DSIR RESEARCH
1976

NEW ZEALAND DEPT. OF SCIENTIFIC & INDUSTRIAL RESEARCH CELEBRATES ITS 50TH ANNIVERSARY.

DSIR 50

annual Reports

FOREST RESEARCH INSTITUTE
P.O. BOX 31[illegible]
CHRISTCHURCH

DSIR RESEARCH 1976

FRONT COVER

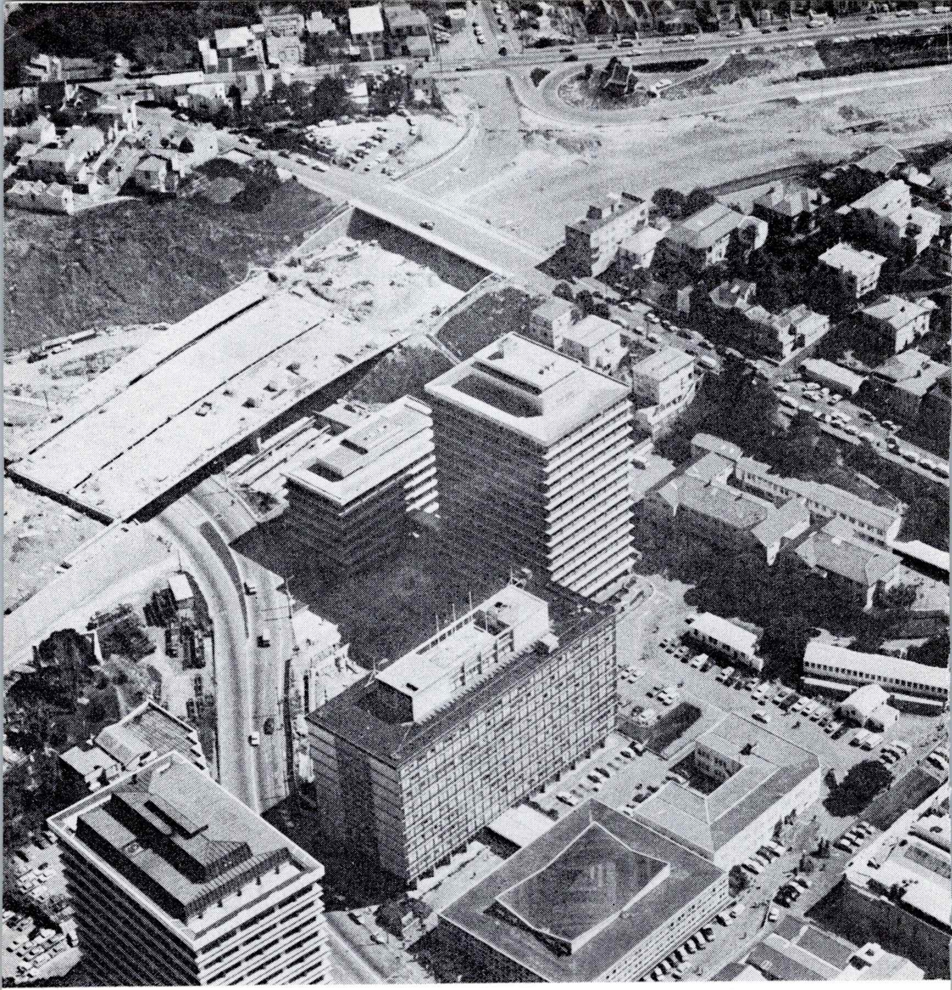
One of the photographic displays for the "DSIR 50" celebrations (actual height about 2 m). It was also mounted in Hobart, at the 47th ANZAAS Congress, and in London. The panels illustrate a variety of DSIR activities, many of which have been described in earlier issues of *DSIR Research*.

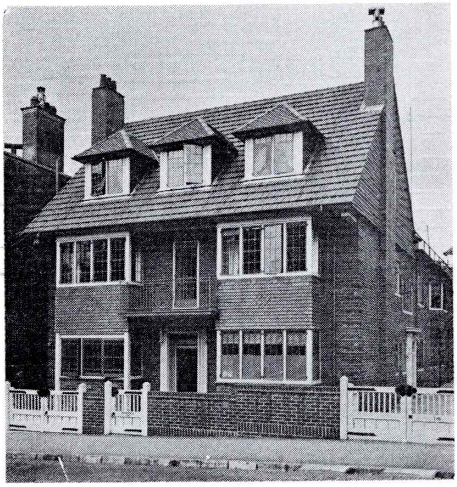
TOP ROW (left to right): *1 & 3,* Geophysics Division aeromagnetic survey; *4,* Van de Graaff accelerator at Institute of Nuclear Sciences.

SECOND ROW: *1, 2, & above,* eruption of Ngauruhoe, studied by Geological Survey and Geophysics Division; *3 & 4,* Oceanographic Institute Research Vessel *Tangaroa.*

THIRD ROW: *1,* tiny parasitic wasp studied by Entomology Division; *2,* radio telemetry for opossum tracking, Ecology Division; *4,* SWISH, the Oceanographic Institute ocean floor instrument package.

BOTTOM ROW: *1,* Tobacco Research Station, mechanical harvesting; *2,* sheep digestion investigation, Applied Biochemistry Division; *3 & above,* Mangaweka deviation viaduct, with Physics and Engineering Laboratory-designed energy absorbers; *4,* Entomology Division insect rearing.





The former Mantell home (left) in Sydney Street West, Wellington, now demolished, which housed DSIR Head Office from 1928 to 1967.

Head Office now occupies two floors in the new Charles Fergusson State Building (the tower block in the centre of the photo above) which stands on the site of the old DSIR building. Next to it is Bowen State Building, with Broadcasting House in the centre foreground.

Most of Sydney Street West has disappeared in the course of construction of these buildings and of the Wellington Motorway (top of photo).

Information series No. 120

DSIR RESEARCH 1976

Review of organisation and activities in the Department of Scientific and Industrial Research and Research Associations

Compiled by the Science Information Division

Photography: by Departmental staff
unless otherwise acknowledged

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Department of Scientific and Industrial Research
Wellington 1976

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1976

INTRODUCTION

This seventh successive annual publication of *DSIR Research* appears during the 50th year since the Department was established in 1926.

The pattern of preceding issues has been departed from. On pages 17-89 activities in all National Research Advisory Council categories of scientific research in which the Department participates are reviewed, instead of a selected few as hitherto. Work and results in the preceding 5 years are covered, and reference is made to earlier work where pertinent in the historical context of the 50th anniversary year.

It is intended to resume next year the 5-year cycle of reviews of smaller groups annually, and every sixth year thereafter to repeat a comprehensive review similar to this year's.

This issue presents in detail the structure and responsibilities of the large research and development organisation that has evolved from the guidelines laid down 50 years ago. A history of personalities and events that have shaped the Department in its first half-century appears in "DSIR's First Fifty Years,*" by Dr J. D. Atkinson, which has been published to mark the anniversary.

The objectives of a national science policy must be to meet the needs of the people. As a major instrument of that policy in New Zealand, DSIR has met the changing public requirements brought about by increased urbanisation and industrial development, great technological advances, and the pressures of export marketing and other economic forces. It is well equipped to meet—and where necessary anticipate—the inevitably increasing demands on scientific services.

E. I. Robertson

Director-General

*** available from Publications Officer, Science Information Division, DSIR, P.O. Box 9741, Wellington at $5.00 per copy, post free.**

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THE DEPARTMENT

Establishment

In 1926 the Government invited Sir Frank Heath, Secretary of the DSIR (U.K.), to visit New Zealand and report on the organisation of civil science. His recommendations were accepted, the Scientific and Industrial Research Act was passed, and in 1926 the new DSIR, with a nucleus of existing laboratories, and an Advisory Council were set up.

Functions

Sir Frank Heath said in his report in 1926 that the day of the pioneer was almost over; the third generation on the land were seeing the need for husbandry of the soil and prevention of disease; the manufacturer was finding the artificial stimulus of the First World War had left him with a capacity to produce beyond his power to use. Sound scientific, technical, and economic guidance was needed in all ventures, and a steady, longsighted policy of help and advice from the State in a national move to attack scientific problems.

From the beginning, the Department aimed at rapid application of the results of research, and close co-operation was maintained with industry and with other Departments of State. Because many New Zealand companies are small, the establishment of research associations has been encouraged; many have come into being as a result of research begun in DSIR, and the three units concerned with wheat, tobacco, and hops remain integral parts of the Department. Grants are made by the Department to encourage scientific developments and special projects in 11 incorporated research associations, the universities, and several other institutions and organisations.

DSIR's work is done in localities throughout New Zealand, and in the Pacific and Antarctic. It is administered from a Head Office in Wellington, and a Scientific Liaison Officer is stationed in London.

Present Activities

Scientific research in the Department today is both basic and applied, and in few countries is such a diversity of fields covered by a single State scientific organisation. However, because of our small population and abundance of scientific problems, many peculiar to New Zealand, there is much to be gained in efficiency and economy by such an organisation.

Although most of the Department's work is concerned with applied science — that is, the pursuit of knowledge for its practical application — some fields have not been adequately explored, and in these "background" research is in progress; for example, the physiology and biochemistry of pasture plants and their utilisation by grazing animals are studied. Similarly, the proper classification of New Zealand plants and animals is necessary before weed, pest, and disease control measures can be satisfactorily established, and the classification of fossils is essential for the dating of geological strata. Intensive biological and chemical surveys of lakes are providing fundamental information to be used in tackling the problem of pollution of the freshwater environment.

There must always be a substantial proportion of such background research if the rest of the Department's work is to be soundly based.

Agricultural research forms a large part of the Department's work. Although most of our easily farmable land has now been occupied, population and economic pressures will demand ever-increasing production from a fairly static area of occupied land, and, under this intensive management, problems of plant and animal nutrition and health are expected to intensify. Present research is aimed at greater efficiency of production and increased quality and diversity of agricultural output.

The Department itself, and the range of skills of its staff and the sophistication of its laboratory and other facilities, have been developed to keep pace with, and often to anticipate, the demands of economic and social progress. DSIR workers are involved along the whole chain from basic scientific studies, through applied research and development, to advisory and consultant services which ensure that results are known and applied.

The Department's policy, research priorities, and forward planning have had to be comprehensively reviewed in the last few years because of unprecedented economic and social developments here and overseas. Important factors considered were: marketing implications for New Zealand of the United Kingdom's entry into the EEC; increasing public concern about environmental and social effects of national development; the oil and energy crisis, effects of which began to be felt here in 1974; the changing attitudes of Government and our overseas customers towards increased processing (and hence added value) of agricultural and other resources before export; and the increasing importance attached to bilateral co-operation with other countries and the provision of technical assistance and other forms of aid to developing countries.

Comprehensive reviews begun or completed recently by DSIR have included oil, gas, coal, and geothermal resources; manufacturing research, development, and services; crop production and processing; food processing in general; ruminant feeding systems, pasture pests, and irrigation; environmental pollution, water quality, and waste treatment and recovery; and nationwide biological surveys.

Expenditure on scientific research 1975/76

The Department spent $23.4 million on its own activities in 1975-76 as follows: agriculture $9.1 million; building and construction $0.9 million; manufacturing $3.2 million; minerals $1.5 million; natural environment $5.3 million; other activities $3.4 million. An additional $3.8 million was granted to other organisations.

Further details of estimated expenditure on scientific research in New Zealand appear in the annual reports of the National Research Advisory Council.

ORGANISATION

HEAD OFFICE

Charles Fergusson State Building, Bowen Street, Wellington
POSTAL ADDRESS: Private Bag, Wellington 1
TELEGRAMS: RESEARCH Wellington TELEPHONE: 729-979 Wellington

DIRECTOR-GENERAL: E. I. ROBERTSON, O.B.E., MSc*NZ*, PhD *Lond*, DIC, FRSNZ.

ASSISTANT DIRECTOR-GENERAL: G. W. Butler, MSc, FilDr *Lund*, FRSNZ.
ASSISTED BY: E. W. Wright, MSc, PhD; D. C. Isaacs, BAgrSc.

ASSISTANT DIRECTOR-GENERAL: D. Kear, BScEng, BSc, PhD, ARSM, FRSNZ, MAIMM.
ASSISTED BY: D. Doyle, BSc, LL B.

ASSISTANT DIRECTOR-GENERAL: I. K. Walker, DSc, FNZIC.
ASSISTED BY: L. P. J. Chapman, MSc, ACA.

ADMINISTRATION

DIRECTOR OF ADMINISTRATION: J. Gould.
ACCOUNTANT: J. Russell, ACA, ACIS.

The chart overleaf outlines the organisation of the Department.

The Director-General as the Permanent Head of the Department is directly responsible to the Minister of Science for implementing Government policy affecting DSIR, including assessment of research priorities, which is reflected in the provision of facilities, staff, and finance to branches. He is also an *ex officio* member of the National Research Advisory Council, established in 1963 to advise the Minister of Science on scientific research in New Zealand.

Three Assistant Directors-General advise the Director-General on specific fields of application of science and are responsible for appropriate groups of branches.

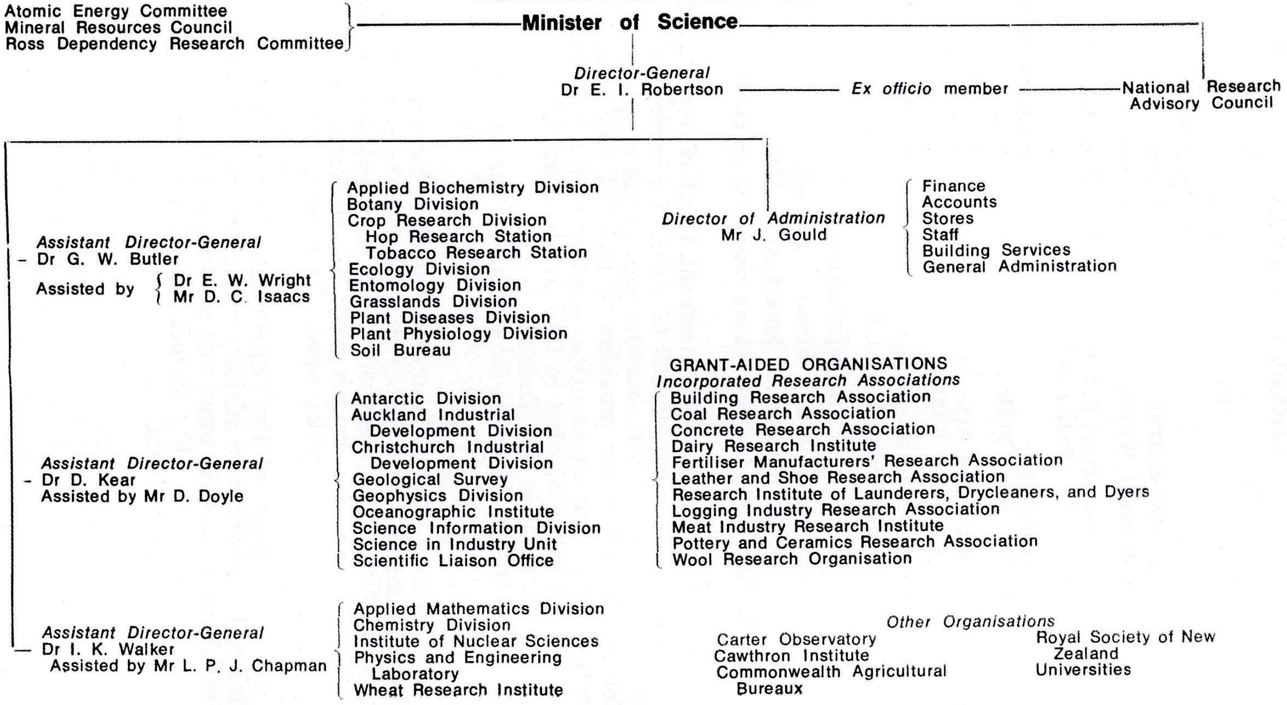
The Director of Administration organises the administrative and clerical service of Head Office and advises branch Directors and Executive Officers on administrative, staff, and clerical procedures.

The Director of a branch plans his programme of research to implement Department policy within the resources of staff and money allocated him.

Several branches of the Department whose work is closely concerned with industry have advisory committees on which scientists and industrial representatives come together to consider current and future research programmes. They include the Wheat, Hop, Tobacco, and Fruit Research Committees.

DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH

ORGANISATION AND ADMINISTRATION



Atomic Energy Committee
Mineral Resources Council
Ross Dependency Research Committee

Minister of Science

Director-General
Dr E. I. Robertson — *Ex officio* member — National Research Advisory Council

Assistant Director-General
Dr G. W. Butler
Assisted by Dr E. W. Wright, Mr D. C. Isaacs

- Applied Biochemistry Division
- Botany Division
- Crop Research Division
  - Hop Research Station
  - Tobacco Research Station
- Ecology Division
- Entomology Division
- Grasslands Division
- Plant Diseases Division
- Plant Physiology Division
- Soil Bureau

Assistant Director-General
Dr D. Kear
Assisted by Mr D. Doyle

- Antarctic Division
- Auckland Industrial Development Division
- Christchurch Industrial Development Division
- Geological Survey
- Geophysics Division
- Oceanographic Institute
- Science Information Division
- Science in Industry Unit
- Scientific Liaison Office

Assistant Director-General
Dr I. K. Walker
Assisted by Mr L. P. J. Chapman

- Applied Mathematics Division
- Chemistry Division
- Institute of Nuclear Sciences
- Physics and Engineering Laboratory
- Wheat Research Institute

Director of Administration
Mr J. Gould

- Finance
- Accounts
- Stores
- Staff
- Building Services
- General Administration

GRANT-AIDED ORGANISATIONS
Incorporated Research Associations

- Building Research Association
- Coal Research Association
- Concrete Research Association
- Dairy Research Institute
- Fertiliser Manufacturers' Research Association
- Leather and Shoe Research Association
- Research Institute of Launderers, Drycleaners, and Dyers
- Logging Industry Research Association
- Meat Industry Research Institute
- Pottery and Ceramics Research Association
- Wool Research Organisation

Other Organisations

- Carter Observatory
- Cawthron Institute
- Commonwealth Agricultural Bureaux
- Royal Society of New Zealand
- Universities

POLICY AND PROGRAMME

In the planning and administration of its scientific research, development, and services; in forward provision for expenditure (the Science Budget); and in the internal allocation of finance and manpower, the Department works within the framework of the National Research Advisory Council's 39 definitions of areas of scientific activity (NRAC Annual Report 1970, revised 1976).

In each annual issue of this publication the broad general coverage of work in these activities is supplemented by an in-depth review of four or five activities on a 5-year cycle. Titles of major reviews that have appeared are:

1972: Human Health; Activities in Antarctica; Dairy Production and Processing; The Environment.

1973: Horticultural Production and Processing; Building and Construction; Meat Production and Processing; The Development of Oceanography in DSIR.

1974: Wool Production and Processing; Transport; Storage; Communications; Atmospheric Sciences.

1975: Soil Resources and Fertility; Manufacturing; Miscellaneous Agricultural Production and Processing; Minerals Production and Processing; Forestry Protection, Production, and Products.

Scheduled to complete the cycle are:

1977: Earth Sciences; Pastures; Crop Production and Processing; Other Scientific Services.

In this issue

Work in a particular activity may be done mainly in one or a few Divisions of the Department, or aspects of it may concern a number of Divisions and a range of disciplines. The table below lists only those activities in which DSIR is substantially engaged. The page references are not exhaustive, but are a guide to significant information on the respective activities and to where and by whom the work is being done. They are supplemented by the Index at the back of the book, where publications of Divisions and Research Associations are also listed.

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Other Scientific Services	88–9, 108, 111, 150

LOCATION DIRECTORY

The following are locations, listed alphabetically, at which components of DSIR and research units partly financed by the Department are based or represented by subsidiary units:

Appleby B3

Plant Diseases Division Research Orchard

Auckland (see also Oratia, Otara, and Pukekohe) C1

Applied Mathematics Division Substation
Auckland Industrial Development Division
Botany Division Substation
Building Research Association Advisory Office
Chemistry Division District Laboratory
Coal Research Association Advisory Office
Entomology Division
Plant Diseases Division
Soil Bureau District Office

Christchurch B4

Antarctic Division
Building Research Association Advisory Office
Chemistry Division District Laboratory
Christchurch Industrial Development Division
Coal Research Association Advisory Office
Geological Survey District Office
Geological Survey Sedimentation Laboratory
Geophysical Observatory
Wheat Research Institute

Cromwell A5

Geological Survey District Office

Dunedin B5

Botany Division Substation
Building Research Association Advisory Office
Coal Research Association Advisory Office
Geological Survey District Office
Soil Bureau District Office

Earnscleugh A5

Plant Diseases Division Research Orchard

Gore A5

Crop Research Division Substation
Grasslands Division Substation
Soil Bureau District Office

Greymouth B3

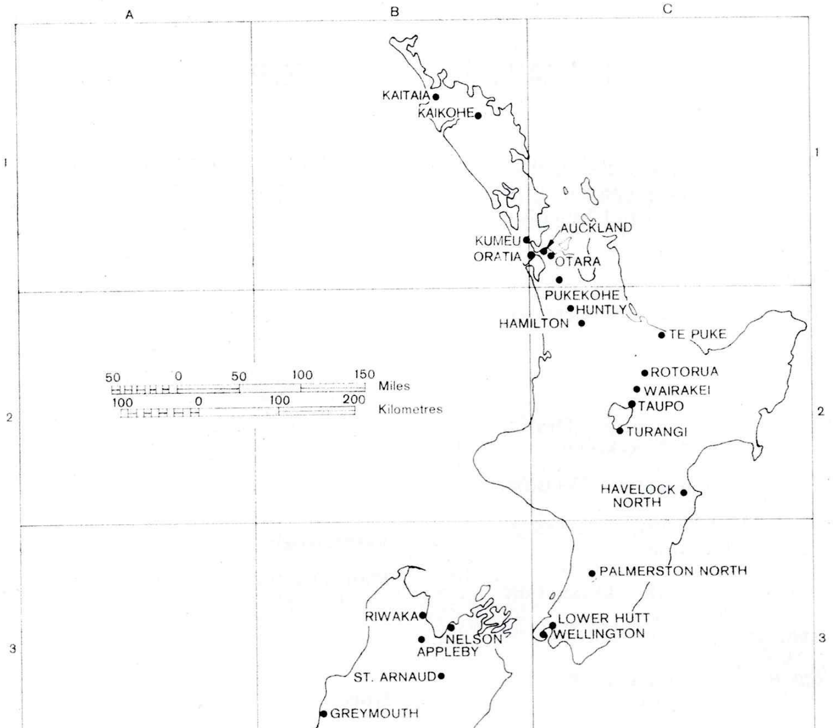
Geological Survey District Office

Hamilton C2

Coal Research Association Advisory Office
Meat Industry Research Institute
Soil Bureau District Office

Havelock North C2

Ecology Division Substation, Bird Research Laboratory
Plant Diseases Division Research Orchard
Soil Bureau District Office



See p. 16 for list of stations beyond New Zealand

Huntly C2

Geological Survey District Office

Kaikohe B1

Grasslands Division Substation

Kaitaia B1

Applied Biochemistry Division

Kumeu B1

Plant Diseases Division Research Orchard

Lauder (see Omakau)

Lincoln B4

Applied Biochemistry Division Substation
Applied Mathematics Division Substation
Botany Division
Crop Research Division
Entomology Division Substation
Grasslands Division Substation
Plant Diseases Division Substation
Soil Bureau District Office
Wool Research Organisation

Lower Hutt C3

Botany Division Substation, Taita
Chemistry Division
Coal Research Association
Ecology Division
Geological Survey
Geophysics Division Geophysics Laboratory
Institute of Nuclear Sciences
Launderers, Drycleaners, and Dyers Research Institute
Physics and Engineering Laboratory
Pottery and Ceramics Research Association
Soil Bureau, Taita
Ecology Division Substation, Taita

Nelson B3

Botany Division Substation
Cawthron Institute
Ecology Division Substation
Geological Survey District Office
Plant Diseases Division Research Orchard, Appleby
Soil Bureau District Office

Omakau A5

Physics and Engineering Laboratory Auroral Station, Lauder

Oratia B1

Plant Diseases Division Research Orchard

Orongorongo Valley (see Wellington)

Otara C1

Crop Research Division Substation
Fertiliser Manufacturers' Research Association
Geological Survey District Office

Palmerston North C3

Applied Biochemistry Division
Applied Mathematics Division Substation
Coal Research Association Advisory Office
Crop Research Division Substation
Dairy Research Institute
Entomology Division Substation
Grasslands Division and Ballantrae Substation
Leather and Shoe Research Association
Plant Diseases Division Substation
Plant Physiology Division
Soil Bureau District Office

Porirua (see Wellington)

Pukekohe C1

Plant Diseases Division Vegetable Area

Riwaka B3

Crop Research Division Hop Research Station
Crop Research Division Tobacco Research Station

Rotorua C2

Geological Survey District Office
Logging Industry Research Association
Soil Bureau District Office

St. Arnaud B3

Ecology Division Field Station

Taita (see Lower Hutt)

Taupo C2

Ecology Division Substation

Te Puke C2

Plant Diseases Division Research Orchard

Turangi C2

Geological Survey District Office

Twizel A4

Geological Survey District Office

Wairakei C2

Chemistry Division District Laboratory
Geophysics Division Geothermal Laboratory

Wellington (includes Porirua; see also Lower Hutt) C3

Applied Mathematics Division
Building Research Association
Carter Observatory
Concrete Research Association, Porirua
Ecology Division Field Station, Orongorongo Valley
Geophysics Division
Geophysics Division Seismological Observatory
Geophysics Division Geophysical Survey
Head Office
Oceanographic Institute
Science Information Division
Science in Industry Unit

Manned Stations Beyond N.Z.

London, U.K.:

N.Z. Scientific Liaison Office, N.Z. High Commission, N.Z. House, Haymarket, London SW1Y 4TQ.

Pacific:

Rarotonga, Cook Islands
(Observatory)
(Plant Diseases Division Research Station)
Apia, Western Samoa (Observatory)
*Raoul Island (Observatory)
*Campbell Island (Observatory)

Antarctica:

Scott Base, Pram Point, Ross Island
Vanda Station, Wright Valley
Cape Bird, Ross Island (manned summer only)

*Administered by Ministry of Transport

COMPREHENSIVE REVIEW OF DSIR ACTIVITIES

SOIL RESOURCES AND SOIL FERTILITY

The growth of soil science in New Zealand

According to tradition the Maoris distinguished different kinds of soil hundreds of years ago. They selected fertile soil for their crops, added sand to heavy soils, and fertilised soils with wood ash and fish waste. Over the period of European settlement, surveyors reported on soils, and chemical analyses were carried out from the 1860s. However, it was 1903 before systematic soil surveys were advocated, and another 20 years before any were completed.

The first soil survey published in New Zealand was that of Rotorua, made by B. C. Aston in 1926, to determine whether there was a relationship between soils and "bush sickness". The New Zealand Soil Survey dates from 1930 when L. I. Grange and N. H. Taylor were seconded from Geological Survey to make a reconnaissance survey of the central North Island as an extension of these investigations.

Taylor produced a soil map incorporating the concept of soil as an entity comprising both topsoil and subsoil. The soil was considered to be a product of interacting processes, at first considered to be only chemical and physical, but later further expanded by Taylor who, in distinguishing a brown soil under scrub and a podzolised soil under forest on Taupo Pumice, recognised the importance of vegetation on soil formation.

The stimulus of the problem of bush sickness and of its likely association with volcanic ash showers prompted a full-scale reconnaissance soil survey of the central North Island, where Grange had now plotted the limits of important showers. This survey, sponsored and led by T. Rigg of Cawthron Institute with Grange and Taylor in the field, definitely correlated bush sickness with the Taupo and Kaharoa pumice showers and an allied stock disease with parts of the Mairoa shower, but showed that other showers were not associated with the disease.

Finance for soil work was difficult during the depression, but the ash-shower surveys were valuable in indicating to the Lands and Native Departments the distribution of healthy and sick soil types in areas where new farms were proposed. This work, with the reconnaissance survey of Taranaki and surveys of the Ashburton and Levels areas for irrigation, kept the Soil Survey in existence.

An inexpensive survey of Waipa County to assess the future of topdressing enabled methods of detailed soil survey to be worked out by Grange and Taylor, and showed correlations between farm practice and soil type. Nevertheless, many agriculturists were critical of the value of soil surveys to individual farms until the results of the district surveys of Hawke's Bay and North Auckland, begun in 1935, were available 2 years later. In Hawke's Bay, the soil survey, undertaken in association with pasture, orchard, and farm management surveys, showed a clear relationship between management practice and soil type. When the extent of the correlation was tabulated in the form of an extended map legend, the value of soil surveys as aids to improving farm practice was acknowledged by agriculturists.

In a simultaneous survey in North Auckland, where there were extremes of vegetation and parent rock, soil sequences worked out in detail clearly showed the correlation between soils and fertiliser responses. In a district of problem areas, the work provided explanations of known problems and convincing evidence of the value of soil science to agriculture. In Whangarei County, W. M. Hamilton evolved a technique of estimating potential production from each soil type.

Mapping

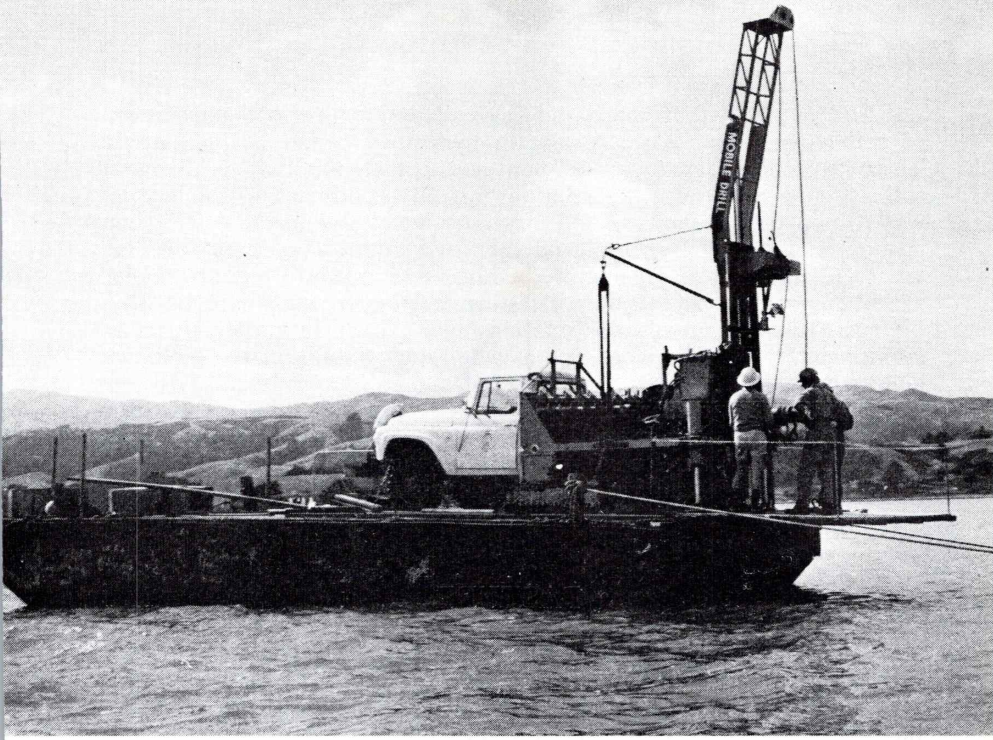
These surveys, aided by chemical analyses, laid the basis for soil classification. The value of mapping was extended by the production of special-purpose maps showing such features as lime requirement, land slope, phosphate content, and soil erosion.

In 1939, field work for the ambitious task of producing a reconnaissance soil map of the entire North Island was completed in about 9 months. A similar project was undertaken in the South Island after World War II.

Publication of these maps and the general acceptance of the value of soil surveys led to a demand for more detailed information, e.g., a survey of the Gisborne Plains to assist the establishment of a food-processing industry; surveys in Otago and Canterbury to evaluate the suitability of soils for irrigation; and surveys of urban areas and their environs to assist town planning development and to prevent unnecessary encroachment of buildings on to good agricultural land. The pastoral orientation of the early soil surveys changed to one satisfying a more diverse set of users.

Many surveys are for some specific purpose, but other factors are also considered, and, where possible, soil surveys are made on a regional basis ahead of likely demand. These "core soil surveys" are broadly based so that results can be interpreted to suit the needs of a wide range of land users and provide a basis for further research.

The basic nature of soil surveying has also changed. Now, deeper layers of soil are examined to provide information for engineering and irrigation. More definitive data, especially physical properties, are being obtained, and there is a trend to produce interpretative classifications for a wide range of uses. The more detailed information now available is being assembled county by county and published as soil maps at a scale of 1:63 360, with extended legends giving soil and land-use data and interpretations. These are part of the Land Inventory Series of maps and reports being produced by the Lands and Survey Department.



Concern at the effects of development on the Pauatahanui Inlet, especially because of increased housing in the area, led to the establishment of a major environmental research study of the inlet and its surrounding catchment. DSIR Soil Bureau and a team of scientists from several other Government departments and universities are evaluating the inlet's present state and sensitive features so that the effect of man's future activities can be assessed. The photo shows a mobile drilling rig taking samples of sediments.

In all surveys, new techniques are being tested and applied to speed up mapping and to improve the quality of the soil data. Several teams may work on one survey to speed completion of the field work. Interpretation of the soil pattern is facilitated by use of black-and-white, colour, and infrared aerial photographs. Mechanised drilling equipment speeds sampling, and computer storage, retrieval, and analysis of field data speed interpretation.

Present emphasis

From the beginning, laboratory support was available for the surveys, and chemists played a very important part in the development of the understanding of soil processes and in defining important properties of New Zealand soils. After the war, other disciplines were incorporated, and the Soil Survey Division was re-organised in 1946 as the Soil Bureau with four divisions – soil survey, soil chemistry, soil physics, and soil biology.

Soil chemists continued to provide analyses for soil surveys, but their work expanded into basic studies of the distribution of the major nutrients in soils and plants; of clay minerals and spectrographic analysis; of differences between soils under pasture and forest; and of the relation between soils and dental health.

Soil physicists developed the fields of agricultural soil physics and of soil engineering. Basic studies in hydrology begun in 1948 at the Taita Experimental Station still continue. Investigations of problems in soil structure and soil water relationships also continue. Soil engineering was started during the war and was later developed to the stage where groups outside Soil Bureau could take over routine investigations. The work undertaken today generally involves research into basic problems.

Soil biologists carried out pot testing and undertook studies on soil–plant and soil–plant–animal relationships. An early project involved copper surveys, and another was a wide-ranging study of the biological factors influencing tussock growth. Since then, survey work has been done on a number of important groups of organisms including earthworms, protozoa, bacteria, nematodes, and microarthropods, and has been extended to studies of population dynamics and organic cycling in a number of natural and managed ecosystems.

PASTURE

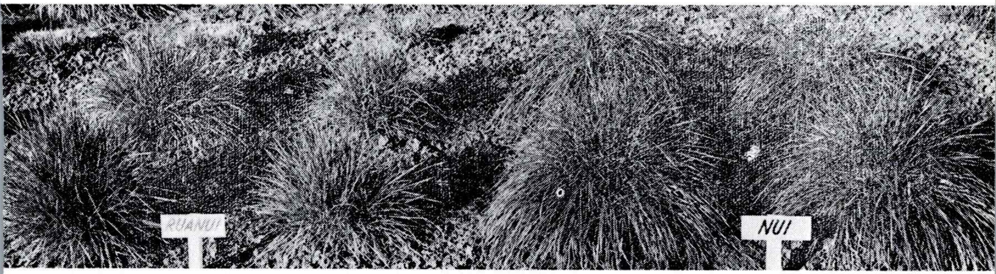
Over the fifty-year period of DSIR's existence, its scientists have been world leaders in research on the soil–plant–animal complex of grassland farming and have quantified for many regions of New Zealand the value of the white clover plant and its nitrogen-fixing capacity in pastures. The understanding and manipulation of the "N-cycle" in New Zealand pastoral production has been responsible for New Zealand agriculture's ability to lead the world in the efficiency of livestock production.

Pasture plant breeding

In 40 years of research effort, Grasslands Division has been responsible for the introduction, breeding, and standardisation of a range of pasture species for use in New Zealand agriculture. Currently, 15 varieties of ryegrasses, cocksfoot, timothy, prairie grass, white clovers, red clovers, and lotus are available for use throughout the country. This has been achieved because the Division has used the expertise of scientists from many disciplines to assess the many factors which have to be selected and bred for to develop strains of herbage plants that will perform adequately throughout New Zealand. The development of these national strains has required thorough evaluation of many hundreds of lines of experimental plant material at regional stations.

Regrowth of pastures

Factors contributing to a better understanding of regrowth of pasture and hence to increasing seasonal and annual production include inter-relationship of light and temperature with growth of component species in pastures, the significance of defoliation processes (e.g., animal treading), competitive inter-relationships between component species in pasture associations, effects of pests and diseases on pasture production levels, and the significance of climatic factors. An important aspect of this work was that it introduced farmers to a scientific approach to pasture management.



The first and the latest of the perennial ryegrasses bred by Grasslands Division. At left, 'Grasslands Ruanui', long the standard ryegrass in New Zealand pasture mixtures. Right, the more productive 'Grasslands Nui', which is available to farmers for the first time this year, and has been found particularly suitable for lowland farming.

Establishment of pastures

Research on this aspect of pasture began in the late 1940s–early 1950s to support efforts to establish good pasture on the pumice plateau of the central North Island. Continued research has highlighted the significance of factors such as the need for rhizobia in soil to enable nodulation of developing clover plants; the dependence of this process on adequate nutrients, particularly phosphorus; the importance of early management to prevent light competition between developing species; the significance of soil nutrient status, especially nitrogen content, on species and pasture establishment; and the effect of seeding rate on the establishment of component species.

Hill country pasture development

This work, initially based in the Whangamomona regions of Taranaki and other areas of the North Island and then centralised at Te Awa, highlighted the need for introduction of legumes into hill country, adequate nutrient applications (usually phosphorus), and soundly based stock management principles if production levels in these regions were to be improved. The very high potential carrying capacity of North Island hill country was demonstrated, and this work is now being extended at Ballantrae regional station.

Regional stations

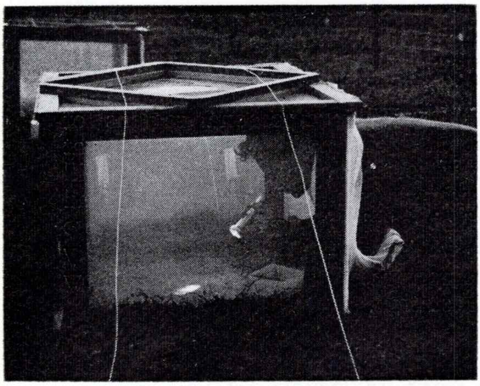
KAIKOHE (warm temperate) — The work on legume establishment on raw gumland soils has resulted in successful pasture establishment and production, making farms on such soils economic. The study of management requirements and use of Paspalum- and/or Kikuyu-dominant pastures for high levels of animal production, and an assessment of performance, growth, and nutritive value of warm temperate (subtropical) plant species introduced into Northland have been of major significance.

LINCOLN (dryland) — Significant contributions have been made to the understanding of nutrient (especially nitrogen) cycling and its importance in the pasture production process in dryland regions. Ecological studies have involved species and pasture establishment and the management of introduced species. The development of management principles has enabled high levels of animal production to be obtained from Tama/ Lucerne association both on dryland and under irrigation, and these principles have been developed for the use of native vegetation in high country regions.

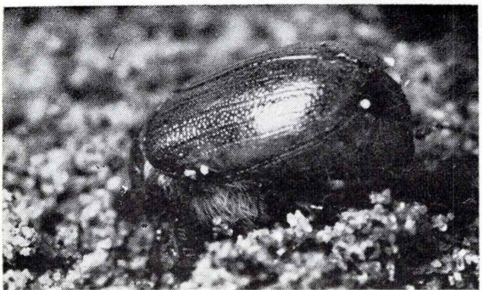
GORE (cool temperate) — Research work has established the feasibility and profitability of all-grass wintering in Southland, and has contributed significantly to understanding of the principles involved in species usage, pasture management, and nutrient cycling in cool temperate regions.

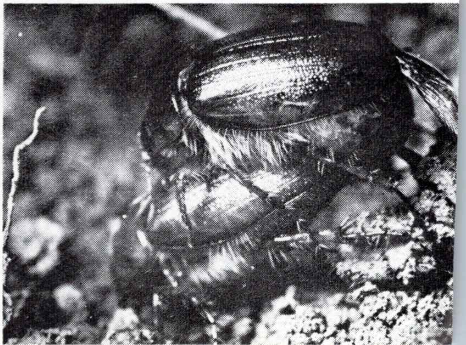
Future activities

Although New Zealand is still more than 80 percent dependent on primary production for export earnings, production potentials are far from being realised in all regions of the country. Production processes in agriculture (soil–pasture–animal) are still not well understood, alternative systems of food production are in their infancy, farming systems that pay greater attention to more efficient use of resources (e.g., phosphate and energy) will be developed, and the need for sensible and planned development of our basic resource – land, is only just beginning to be realised.



Observing adult *Costelytra zealandica* beetles emerging at dusk. In its larval stage this insect is known as the grass grub, a widespread native which is one of the most damaging to pastures. Entomology Division's study of the insect at larval and adult stages is part of a large programme aimed at control of this economically serious pest.





Pasture pests and diseases

SOIL NEMATODES — In collaboration with the Ministry of Agriculture and Fisheries, Lincoln College, and agricultural chemical suppliers, field experiments have been conducted by Soil Bureau to assess the effects of nematocides and methyl bromide sterilisation on clover root nematodes.

The results of trials in three different regions of the country showed that the application of nematocides, in some instances with soil sterilisation, increased the total yield of pure swards of white clover by varying but significant amounts. Seed coated with a nematocide was found to produce more vigorous clover plants during establishment, and cropping reduced root nematode populations to such a low level that subsequent treatment with a nematocide did not significantly increase yield.

Fertiliser trials suggest that the response of pasture growth to additional superphosphate is partly depressed by a corresponding increase in root-feeding nematodes. This, and a survey of nematodes of 55 pasture sites from all parts of New Zealand, has induced a range of pot experiments to assess the effect of a number of nematode species on growth of white clover and ryegrass at various fertiliser and moisture levels.

CONTROL OF RABBITS — Research on rabbits began in Ecology Division about 25 years ago. For many years this research provided almost the only scientific biological input into the astonishingly successful campaign against rabbits waged by the Rabbit Destruction Council and regional rabbit boards. As rabbit numbers were reduced, however, it became increasingly obvious to biologists, and some rabbit board supervisors, that the objective of exterminating the "last rabbit" in New Zealand could never be achieved.

This view was not popular and scientists were criticised for not attempting to develop better methods to achieve complete eradication of rabbits. However, they were able to demonstrate convincingly that it was quite uneconomic to go on killing rabbits in many situations. Acceptance of this resulted in the adoption of a realistic policy which acknowledges that, while control of the rabbit population at a low level is feasible and economically possible, complete extermination is not.

PLANT RESISTANCE TO PASTURE INSECTS — Confirmation that some plants have resistance to attack by grass grub, black beetle, and porina offers a new dimension in the search for methods of controlling these economically important pasture pests. DSIR and the Ministry of Agriculture and Fisheries are screening a wide range of currently used cultivars for evidence of resistance. In the short term, any resistant varieties found can be incorporated in farming systems. Longer-term studies on the nature and mechanisms of resistance are aimed at providing essential information to assist the plant breeder in developing more resistant varieties. *Lotus pedunculatus* has proved particularly interesting as it contains powerful, and apparently specific, feeding deterrents to grass grub, black beetle, and porina.

Rhizobium strains and legume inoculation

The symbiotic fixation of nitrogen from the atmosphere by *Rhizobium* bacteria in the root nodules of pasture legumes was one of the cornerstones of the pasture ecosystems developed by Levy and his colleagues at Grasslands Division in the 1930s. Clover ecotypes which grew vigorously in the absence of added fertiliser nitrogen were used in the development of improved clover varieties. Factors conducive to the establishment of legumes and the vigorous operation of the *Rhizobium*/legume symbiosis have been research subjects of high priority for pasture ecologists, supported by biochemists and microbiologists.

For some legumes and for some areas of grassland, it is necessary to inoculate the seed with a suitable strain of *Rhizobium* because appropriate strains are not present naturally. Plant Diseases Division has been active in the development of suitable techniques for inoculation of legume seed since the late 1930s, and in association with Grasslands Division and the Ministry of Agriculture and Fisheries has studied the problems associated with successful legume establishment in difficult environments (such as the pumice soils of the Central Plateau and dryland areas of Otago). Research programmes have had considerable success, but are still given high priority.

Since the 1950s, methods have been developed for measuring the amount of nitrogen fixed in legume/grass pastures. Techniques of indirect measurement have given way to more direct methods which can be carried out under a wide range of field conditions. A co-ordinated trial using data from sites throughout the country is providing the first detailed information on the extent to which symbiotic nitrogen fixation occurs in each season of the year.

These studies have assumed greater significance in recent years with the realisation that the manufacture of nitrogenous fertilisers requires a high energy input. Any increase in symbiotic N-fixation would reduce the amount of nitrogenous fertiliser needed on pasture and so by taking advantage of our equable climate will increase pasture production at low energy and fertiliser cost.

Work is also being done on the ecology of rhizobia strains in the field to identify and select those that are efficient in N-fixation and persistent and strongly competitive with other naturally occurring strains. For similar reasons, the development of legumes with lower requirements for phosphate fertilisers is of high priority and is another and perhaps the most challenging part of the research programme.

Very recent research has also focused on other free-living soil micro-organisms and the possibilities for establishing quasi-symbiotic relationships between such organisms resident in the root rhizosphere and the associated plants. Studies of the biochemistry and genetics of biological nitrogen fixation have been emphasised in recent years, since it is felt that this is a process which we should be able to manipulate further to New Zealand's considerable advantage in the future.

CROP PRODUCTION AND PROCESSING

Cereal yields

An important function of Crop Research Division is to breed new and improved cereal varieties with higher yield and processing quality and with increased resistance to disease. The success of the breeding programme is evident in that, in 1972, Lincoln-bred cereals accounted for at least 92 percent of the area in wheat in New Zealand and 73 percent of the area in oats, including nearly all the milling oats harvested.

The value of the wheat breeding programme shows mainly in higher yields, although varieties with improved baking quality have been released. In the 5-year period 1933–37 the Dominion average yield was 2200 kg/ha, while in 1972 with newer wheat varieties and improved crop husbandry, and in spite of considerable drought damage, the average yield of the main varieties was 3600 kg/ha.

It is very difficult to compare the contributions of plant breeding and husbandry to this increase because there have been major changes in cropping practices since 1930. However, the new varieties Kopara and Karamu have yields estimated at 12 and 24 percent more than the varieties they are replacing, Aotea and Gamenya respectively. Future increases will be attributable entirely to plant breeding as the new and older varieties will have been grown with the same modern husbandry techniques.

Potatoes

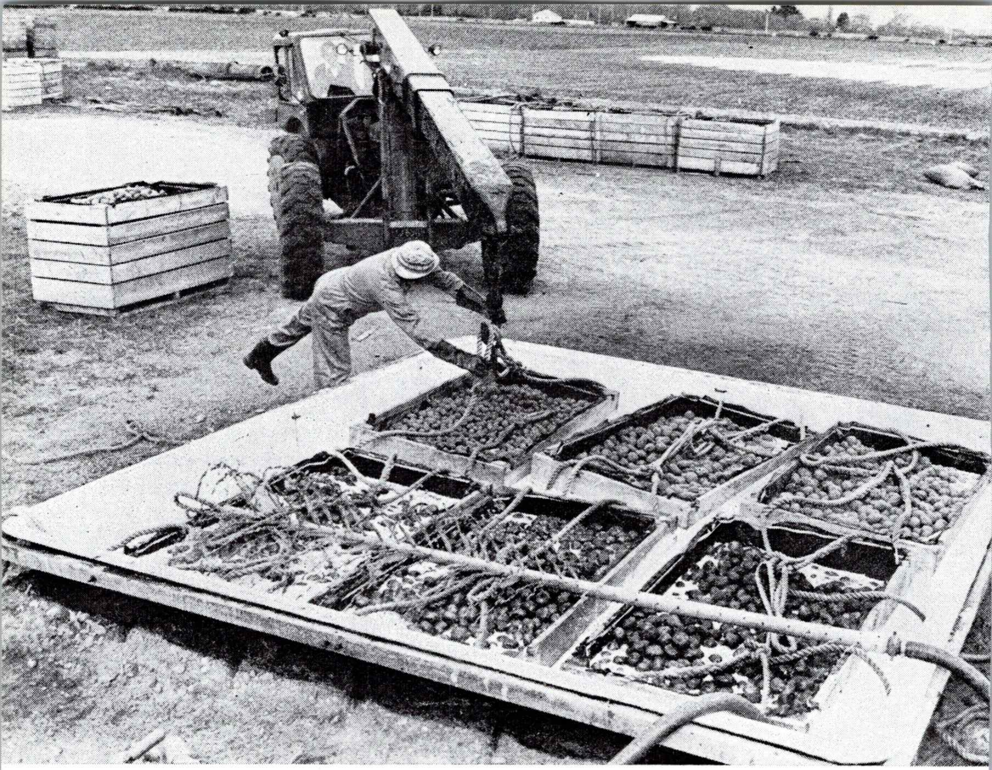
Potato yields are notoriously variable in New Zealand. The initial American varieties grown have gradually been replaced by local ones. Eight high-yielding potato varieties have been released by Crop Research Division from a programme of breeding for strong growth and disease resistance. Some of these meet the demand for a high-yielding variety that does not produce oversized tubers on the more fertile soils of modern farms.

Yields have risen, so that the New Zealand population of 3 million people is now supplied from the same area as fed 1¾ million people 30 years ago.

At one time potatoes were grown almost solely for domestic use, but an increasing proportion of the crop is now sold for processing. Processors want potatoes high in solids, low in sugars, and of firm texture, and they want them to retain these qualities. Waru is one promising processing variety, specially selected for North Otago growing conditions, which has found ready acceptance for the manufacture of dehydrated potato flake, frozen french fries, and crisps.

Plant protein

For some years now considerable emphasis has been placed by Applied Biochemistry Division on the testing of different sources of feed-grade protein, including various seed meals and the leaves of pasture plants. Until New Zealand develops a cheap source of good quality feed, the pig and poultry industries will remain subordinate to sheep and cattle. Early work showed that leaf protein concentrates prepared from lucerne contained a potent photosensitising agent that



Field treatment of potato tubers to destroy cysts of potato nematode. Nematode-infested tubers and soils are completely decontaminated after immersion for 2 h in a solution of sodium hypochlorite. If the method is used for seed potatoes, they can be transported to "clean" areas for sowing instead of being sold as table potatoes, or destroyed. *Photo: Ministry of Agriculture and Fisheries.*

resulted in severe skin lesions in white rats, mice, and pigs. The active ingredient responsible was identified and a method was devised for separation of the edible protein from lucerne and other green leafy material. Sweet lupin as a protein source has been investigated. Its seed protein was found to be of excellent nutritional value once a sulphur amino acid deficiency had been compensated for.

Hop research

The Hop Research Station was formed because root diseases were beginning to threaten continued hop growing in Nelson Province. The causative organism was identified as a species of *Phytophthora,* and a breeding programme led to development of three varieties (First Choice, Calicross, and Smoothcone) resistant to the disease. At about the time when these were released (late 1950s) workers elsewhere in the world were defining more precisely the constituents of the hop cone, and were identifying those which imparted flavour, bitterness, and aroma to the brew, so the next breeding objective was hops with the newly identified desirable characters in addition to *Phytophthora* resistance.

It was agreed that by far the most important constituent for flavour was the percentage of alpha acid and that excessive tannin was detrimental. As most of the tannin is contained in the seed of the hop, the Station aimed to produce *Phytophthora*-resistant varieties which gave heavy yields of seedless hops containing a high percentage of alpha acid. Resistant females in Smoothcone and First Choice were selected as parent material. Work elsewhere indicated that if the usual commercial varieties were grown away from males, the percentage of alpha acid of their cones would increase although crop weight would be less. The answer might lie in producing triploids, i.e., infertile varieties with multiple sets of chromosomes.

By doubling the chromosome complement of the plants, more vigorous hops bearing huge elongated cones that contained large numbers of seeds were obtained. Crossing these plants with normal males led to production of female plants which, although extremely variable, contained a number of types giving heavy yields of hops, the cones of which contained very few seeds but a high percentage of alpha acid. Examination showed that these were triploids.

From a large number of seedlings raised in this way, three varieties, Green Bullet, Sticklebract, and Harleys Fulbright were released commercially in 1970. Experience with these varieties has shown that Green Bullet and Harleys Fulbright have retained virtually complete resistance to root rots, but Sticklebract has not. The high alpha acid and seed percentage have remained fixed.

The Riwaka-bred seedless triploids now constitute almost half the New Zealand hop acreage, and the Station has a further range of triploid seedlings under evaluation.

Tobacco research

The tobacco crop grown in New Zealand is mainly flue-cured and the research effort is therefore concentrated on the variety *Nicotiana tabacum*. *Verticillium* wilt attacks many crops in many different parts of the world, but it infects only tobacco in New Zealand. The first identification was made in 1943 and, as with other soil-borne diseases, it has spread markedly since that time. The Tobacco Research Station started seeking sources of resistance within the *Nicotiana* genus in 1948 and released the first *Verticillium* wilt-resistant flue-cured tobacco cultivar – Waimea – in 1967. A further release with greatly improved resistance to the disease and a leaf quality which compares favourably with

Wilt-resistant cultivars of tobacco (left) developed at the Tobacco Research Station, Riwaka, show a marked contrast to more susceptible varieties (right).

the normal commercial cultivar, Hicks Broadleaf, was made in 1973 and called Kuaka 427.

Economic improvements in the management of the crop have resulted from research into planting on ridges, the use of fatty alcohols to control axillary bud growth, plant spacing, and maturity of leaf at harvest.

Pollinators for lucerne

New Zealand seed yields from lucerne are very much smaller than those obtained in other areas, particularly North America. Much of the difference is attributed to the inadequacy of honey bees and bumble bees as lucerne pollinators in this country. In an attempt to improve lucerne seed yields, Entomology Division introduced two bee species which are specifically managed to pollinate lucerne in the United States. One species, the alkali bee, was successfully established in a coastal location in Marlborough, but although its numbers are increasing they are not yet high enough to affect lucerne pollination. The second species, the lucerne leafcutter bee, shows promise for use in warmer inland areas. Stocks of leafcutter bees are being increased and managed under DSIR control. Where leafcutter bee numbers are sufficiently high, increased seed yields have been obtained.

Disease-resistant lucerne

Bacterial wilt is a destructive disease of lucerne in parts of Otago, Canterbury, Hawke's Bay, and the volcanic palteau. The disease limits production and the life of the lucerne stand, particularly in irrigated crops, or in crops grown on wet soils and cut frequently.

Saranac, an American lucerne resistant to bacterial wilt, is now being grown in Canterbury and Marlborough. New techniques of seed production are being used; and, with the prospect of high yields, enough seed should be produced for local requirements this year. A new cultivar, Washoe, resistant to wilt and stem eelworm, has been recommended for use in areas infected with eelworm, which has caused severe reductions in spring production, particularly in South Canterbury and North Otago.

DSIR and MAF have co-operated in sowing a series of lucerne trials of cultivars resistant to a number of diseases. These New Zealand-wide trials should help in identifying disease problems and recommending the most suitable cultivars for particular areas.

Control of diseases

All crops grown in New Zealand suffer losses from plant disease to some extent. However, for most field crops the net return per hectare to the grower is relatively low and it is usually not economic to control diseases by spraying. For seed-transmitted fungal and bacterial diseases, chemical treatments of seed have proved successful and have been widely employed. An example is the use of captan for controlling seed-borne diseases of wheat. Usually, however, other strategies have to be adopted: for example, the avoiding of barley yellow dwarf virus in winter wheat by sowing seed only after the main flight period of its aphid vector has passed. Sometimes disease losses have been reduced through altered management or cultural practices after the biology of the causal organism has become thoroughly understood – as in the control of dry rot of swedes by destroying or removing the plant residues which harbour the fungus. Longer-term solutions have been sought by selective breeding based on resistance to a particular disease – as in controlling bacterial wilt of lucerne, described above.

Control of rooks

Damage by rooks to cereals, peas, and other crops in central Hawke's Bay was assessed at $100-150,000 per annum during 1968-70. Although poisons, especially compound 1080, were sometimes successful in reducing their numbers, this compound was unreliable, dangerous to handle, and toxic to other species.

Research by Ecology Division demonstrated that the poison DRC-1339, originally developed for starling control in the United States, was effective against rooks and much safer than 1080; and that bread baits were accepted more readily when insects and earthworms were scarce. This shortage of animal foods, often associated with frost or drought, was indicated by large flocks of rooks gathering to feed on crops, stock foods, and stubble.

Using this information, and collaborating with Ecology Division, the Hawke's Bay Pest Destruction Board successfully reduced rooks in the Heretaunga Plains by 80 percent with little mortality to other species; many rookeries were completely abandoned and some are still deserted three years later.

Crop processing

Recent years have seen increased processing of crops in New Zealand and the development of new products. A large range of plants are now grown and processed for export and for local consumption. Constant research has been necessary to develop new products, and to overcome processing difficulties.

Drying is often necessary to reduce unwanted weight for transport and to ensure adequate keeping qualities. For most crops, drying without damage must be carried out under carefully controlled conditions, and this requires expensive and sophisticated equipment. This is particularly so for seed drying, where the temperature must be kept below 40°C to avoid a deleterious effect on germination. Chemistry Division expertise applied to studies of technical feasibility, product quality, and comparative economics of drying methods has shown that fluidised bed drying is particularly suitable compared with conventional vacuum drying. The work is being done in co-operation with a South Island-based seed producer, and the results will be used to determine the best drier design for plant expansion.

When New Zealand-grown tobacco was first introduced it was not readily accepted by the industry nor by consumers. A study was therefore made of conditions in the kiln to see how they affect manufactured tobacco. This research led to design of a new kiln with a forced circulation of warm humid air in a downwards direction (i.e., opposite to the natural circulation). The new kiln yields a better quality leaf, more uniform in characteristics, and also reduces the time necessary for curing.

When varieties of hops are made available to New Zealand growers, it is necessary to carry out processing trials on plants grown under local conditions, since quality and aroma help govern the choice of a variety for production. The kilns used in the hop industry were designed collaboratively by scientists of the Hop Research Station and chemical engineers from Chemistry Division.

Although not an export industry, the wheat processing industry is quite large – in 1971 about 300 000 tonnes of wheat was converted into flour, bran, and pollard, to a total value of $24 million. The Wheat Research Institute has developed a wheat testing service to supply flour-millers with information on the baking quality of individual parcels of wheat at time of purchase. During the wheat harvest, grain merchants forward samples to the Institute, where they are milled and baked at the rate of one sample a minute. Millers can thus select the best wheat for milling, and can exclude wheat with serious defects such as sprout and "bug" damage.

In the production of maize, the biggest single cost is drying after harvesting so that the maize can be safely stored. Auckland Industrial Development Division has helped Waikato farmers in designing and building first a simple bin drier, and now a radial-flow bin drier. These driers are simple, cheap to build, and economical to operate. As a result of AIDD's efforts the associated problems of sampling and determination of moisture content have also been put on a sound basis.

The export of lucerne meal and pellets has been a flourishing industry for many years, and the industry has been assisted with the design of new driers, and with tests to demonstrate that the export product is free from hazards of spontaneous combustion.

Crop Research and Chemistry Divisions are carrying out research into the possibilities of growing and processing oil crops in New Zealand. In addition to linseed, investigations are being made of rape seed and sunflower as sources of oil. Another promising crop is peppermint oil, and trials are under way to extract this from the dried leaves of *Mentha piperita*.

HORTICULTURAL PRODUCTION AND PROCESSING

Breeding disease-resistant glasshouse tomatoes

The area of tomato crops under glass in New Zealand is about 100 ha, annual production is about 15 000 tonnes, and wholesale value is over $6 million. The crop is vulnerable to diseases, the major ones being tobacco mosaic virus (TMV), leaf mould (*Cladosporium fulvum*), and *Verticillium* and *Fusarium* wilts, which can reduce yield and quality by more than 50 percent.

A breeding programme at Crop Research Division is aimed at incorporating multiple disease resistance in different hybrids. The first releases from the programme, Moncross, Vantcross, Veecross and Ycross, which have resistance to leaf mould and to TMV, have proved successful. Vantcros has become the most popular with growers and markets, and it is difficult to satisfy the demand for seed of this hybrid. These new varieties have reduced the import of expensive seed.

Experimental hybrids with broader-based resistance to TMV and leaf mould appear even more promising. Further parent material with resistance to *Verticillium* and *Fusarium* wilts will be used in hybrid combinations for multiple disease resistance.

Selection in Pukekohe Long Keeper onions

In recent years an average of 1200 ha of onions has been grown in New Zealand, with a bulb production of up to 38 000 tonnes per annum. Over 14 000 tonnes have been exported and 2000 tonnes processed.

As export outlets vary, and regular, local supplies are needed, part of the crop has to be stored for several months. Some strains of the well-adapted Pukekohe Long Keeper cultivar fill this requirement. However, there is considerable variability in time of maturity, size, colour, and shape of bulbs, and storage life in the strains being grown. These strains are mostly maintained by local growers without any real assurance of stability of selection or in continuity of supply of seed. In order to prevent the loss of valuable characteristics in this cultivar, Crop Research Division has undertaken to produce and maintain a maincrop strain suitable for long storage. Special attention is given to bulb uniformity and skin adhesion, which are important factors in preventing damage during mechanical harvesting and handling.

Climate Laboratory studies

The Climate Laboratory at Plant Physiology Division is run as a national research facility available to scientists in all DSIR divisions, the Ministry of Agriculture and Fisheries, Forest Research Institute, and the universities. It consists of 24 walk-in rooms in which temperature, humidity, day length, light intensity, and carbon dioxide levels are controlled. Special conditions (e.g., 10°c frosts) can be provided upon request.

Since the laboratory was opened in 1970 more than 130 experiments involving 39 species have been completed. In the majority, the physiological effects of temperature, light, and water on plant growth and development have been examined, but the rooms have also been very useful in determining the environmental conditions under which certain plant pathological problems develop.

Experiments have included studies of the effects of cool temperatures on sorghum grain yields, frosts on pine seedling survival, temperature on kiwifruit bud abortion, growth hormone and temperature interactions on tomato ripening, and water stress on growth of pasture species.

Virus-free horticultural varieties

Most New Zealand cultivars of pip fruit and grapes and many of stone fruit are infected with one or more viruses or virus-like diseases which significantly depress yield. Sometimes, virus infection can be eliminated from vegetatively propagated material by growing suitably prepared young plants at high temperatures (38–40°c), and either grafting tips from shoots so produced on to healthy seedlings or growing them on their own roots. By using these techniques, and by selecting naturally uninfected plants, Plant Diseases Division has been able to build up "virus-free" collections of 40 apple and pear, 52 stone fruit, and 22 grapevine cultivars and rootstocks, most of which are available to the horticulture industry. Trial results show that virus-free Golden Delicious apple trees give almost double the yield of fruit, and that grapevines freed from viruses can produce up to four times as much fruit, of improved sugar content and enhanced wine quality.

Intensive apple production

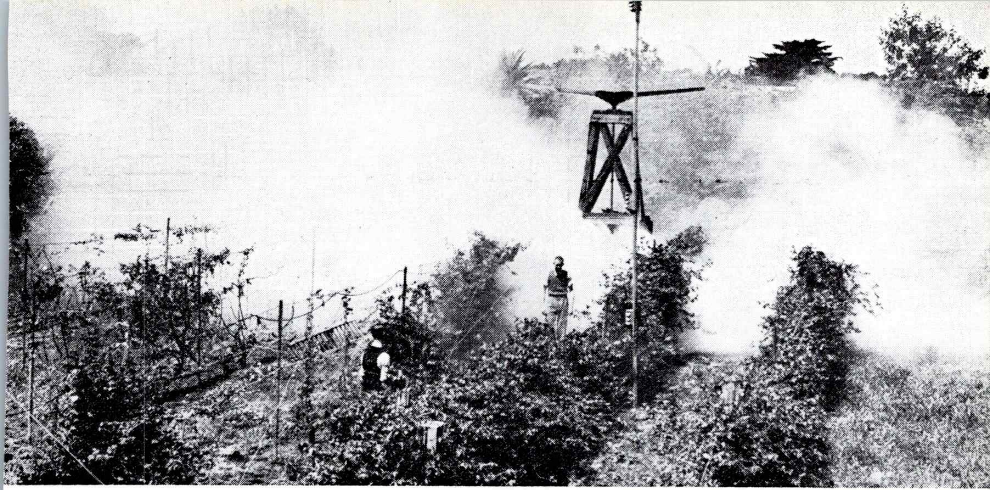
Increasing costs and shortages of labour have forced fruit growers to reconsider many of their traditional practices, and everywhere there has been interest in ways of producing more apples for less effort. An innovative approach to this problem by pomologists of Plant Diseases Division proved particularly successful and has led the way for countries outside Europe. A strict tailoring of tree size was favoured to save space and eliminate much ladder work, trees were planted much more closely, almost as hedges, and the customary laborious training of trees to a vase shape was abandoned in favour of the single-leader or spindle-bush shape. The combination of these methods with the introduction from England of special early-cropping rootstocks was demonstrated to give very heavy production within only a few years of planting, especially on fertile soils such as those of the Hastings district. As a result, this intensive production system has since been widely adopted in all New Zealand apple-growing areas, with substantial economic benefit to orchardists.

Frost protection in orchards

Spring frosts are a major threat to fruit production in some New Zealand orchards, particularly those in Central Otago. Traditionally, most growers have obtained protection by burning diesel oil in fire-pots, a method to which there are several objections, especially the increasingly high costs and atmospheric pollution. For some years Plant Diseases Division has been experimenting with water sprinkling as a cheaper alternative. The method depends on the latent heat released by the water as it freezes. This prevents the temperature of the fruit from falling below freezing point provided that sufficient water is added throughout the frost. Already many sprinkler systems have been installed in Central Otago, and with greatly increased prices for oil, the trend is rapidly gaining ground.

Disease control in horticulture

In contrast to field crops, the unit-area value of many horticultural crops is very high, and so it becomes most important, and very worthwhile, to prevent losses from disease. The development of chemical and engineering technology has enabled the application of therapeutants which are highly selective in controlling particular diseases. Control has thus been achieved of some especially intractable fungal and bacterial pathogens such as those which cause brown rot and blast of stone fruit. A disadvantage of some of the most effective modern chemicals is that disease organisms are apt to develop resistance to them, and spray programmes must be carefully designed if this is to be avoided. The increas-



An attempt (in the 1950s) at assisting fruit-growers to protect their crops from frost damage. A fan draws down the warm layer of air trapped by thermal inversion.

ing costs of purchasing and applying chemicals have encouraged efforts to reduce the amounts used, which brings the risk that the application of inadequate amounts may promote resistance. However, studies have led to a better understanding of factors which favour the outbreak and spread of some diseases, allowing optimum amounts of chemicals to be applied at times when they have maximum effect.

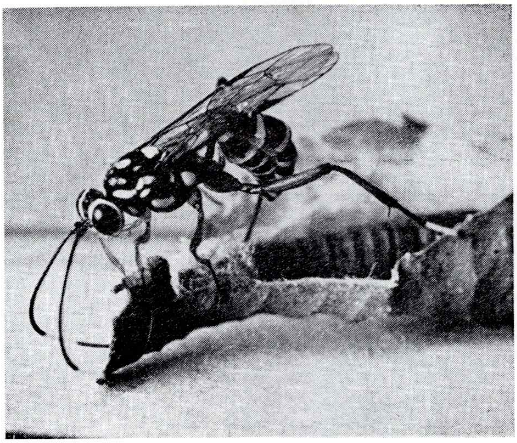
Bitter pit

Bitter pit has been known for many years as a physiological disorder leading to a serious storage problem in apples from young trees or trees in light crop, especially when the fruit is picked immature. It is particuarly common in Cox's Orange, but also occurs in several other varieties, and can appreciably reduce overseas prices for exported fruit. Only comparatively recently was it realised that bitter pit is associated with a localised deficiency of calcium in the fruit, and that its incidence can be significantly reduced by spraying developing apples regularly, from petal fall to harvest, with calcium nitrate. Despite this treatment a good deal of trouble is still experienced in some orchards in some seasons, and ways of treating fruit after harvest without inducing superficial damage are still being sought.

Control of apple pests

The escalation in cost of pesticides has given added emphasis to the need to develop methods of pest control which minimise the use of chemicals and make maximum use of biological agents and management techniques. This is especially so in apple orchards where pesticides represent a major production cost. Entomology Division has been working towards integrated control systems for apple pests along three main lines.

The integrated mite control programme depends on the use of organophosphate-resistant predatory mites and spraying with organophosphate insecticides for control of European red mite. Selective miticides may be used to assist predatory mites on mite-susceptible varieties of apples. This programme has now been extended to monitoring in a small number of commercial orchards where organophosphate-resistant



As part of the programme of research on integrated control of insects in apple orchards, introduced parasites of light brown apple moth are being established in New Zealand. The Australian species *Gambrus stokesii* is shown depositing an egg on the pupa of the host insect.

predatory mites are present, with consequent savings in the use of miticides.

In the supervised spray programme, minimum use is made of conventional chemicals by applying them only when pest numbers approach economic thresholds determined by monitoring. Good control of major insect pests has been obtained by this method although a further reduction in leafroller damage is required. For satisfactory mite control by this method the system for determining economic thresholds needs improvement.

The integrated pest control programme makes maximum use of biological controlling agents including parasites, predators, and insect viruses. Although promising results have been obtained, implementation of this method must await safety clearances for the field use of insect viruses.

Parasites of leafrollers

Leafrollers are among our most prevalent horticultural pests, attacking a wide range of fruit crops and consequently constituting a threat to major export markets. The wide range of host plants contributes to their pest status because there are large reservoirs of leafrollers outside commercial orchards. Regular insecticide schedules cannot prevent the constant reinvasion of crops. However, parasites and predators may effectively reduce pest reinvasion by attacking the pest outside the crop.

For this reason Entomology Division undertook a programme for the introduction of parasites, and an officer of the Division went to Australia in 1967 in search of such parasites. A much wider range than is usually possible of parasite species (nine) were introduced and released. Monitoring of the released parasites, assisted by a national leafroller survey undertaken by the Division in collaboration with the Ministry of Agriculture and Fisheries, has already confirmed the successful establishment and increasing abundance of four of these parasites.

Leafroller larvae are reared to the adult stage, when they are more easily identified, as part of Entomology Division's research on parasites of this major pest. Here larvae are being removed from feijoa leaves and put in test tubes containing an artificial diet.

Horticultural processing

Many products of horticulture are processed in New Zealand, and flourishing export industries are based on the findings of DSIR research. A recent investigation of purple discoloration in canned apple sauce showed how this defect could be avoided. Research on onion curing showed that neck rot (a fungus disease) could be controlled if freshly harvested onions were held in a stream of air at 37°C for 7 days. A plant has been built, and is now operating successfully. Methods are being developed to export green sprouting broccoli in a frozen condition, and pilot trials have been successfully completed on drying condiment herbs for export – caraway, chervil, chives, coriander, dill, fennel, parsley, sage, sweet marjoram, and thyme.

Peach canning in New Zealand is confined almost entirely to Golden Queen, a variety that matures in early March when the weather is normally unsettled. Golden Queen is frequently attacked by brown rot, and losses are sometimes disastrous. Since peaches are less susceptible to brown rot when still green, there has been a tendency to pick at this stage to avoid loss in the orchard, but canned green peaches are leathery and tasteless. If they are held a few days to ripen they are likely to develop brown rot and become a total loss. Research has shown that an American technique of dipping the fruit in warm (50°C) water for 10 minutes destroys brown rot fungus. The fruit will then ripen normally when subsequently held at temperatures of 24–27°C for several days. If necessary, the ripened fruit can be cool-stored up to 3 weeks at temperatures of 0–2°C with little loss from brown rot.

A comprehensive study has been made by Plant Diseases Division on problems involved in processing apple juice to determine reasons for the development of hazes due to pectins, starch, tannins, and metal complexes. These hazes greatly reduce the value of the product. Both enzymic and mechanical means of removal have been used to remedy the problem. Chemistry Division has carried out analytical studies on the constituents responsible for flavour in apple juice from different varieties, and in apple wine.

Red tamarillos are well established on the New Zealand market as a fresh fruit, but their limited storage life restricts potential for export. A fruit drink made from the red tamarillo has been successfully introduced into the food industry. Difficulties were experienced initially in scaling up from a pilot operation to full-scale production, but these have now been resolved.

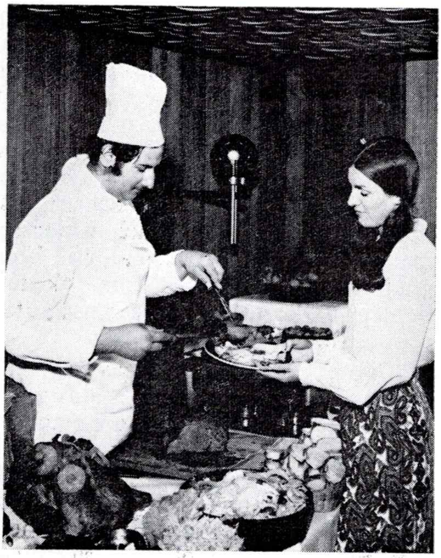
New varieties of tomato are being bred with specific fruit characteristics suited to mechanical harvesting, handling, and processing. This demands fruits that all ripen together, with tougher skins than normal, and a thicker fruit wall. Plants are being developed that show high yields of good quality fruit, well suited for canning whole. For production of tomato pulp, paste, and powder, fruit shape and size is not important. Breeding research for this type of processing is aimed at production of fruit with good colour and flavour, and a high solids content.

PRODUCTION AND PROCESSING OF ANIMAL PRODUCTS

A marked feature of New Zealand agriculture is the increasing amount of material that receives some processing before export; wool is scoured or made into carpets, meat is packed as joints or boned, and milk is made into a wide range of sophisticated products. Most of the research needed to support these industries is carried out by research associations, to which DSIR contributes finance, and in universities or the laboratories of the relevant industry. Extensive research on the processing of agricultural produce is also done within DSIR. Some of this is concerned with defects that occur with traditional produce, and ways of correcting them; but most is concerned with new products. Research is carried out on the basic chemical engineering needed to carry the product through pilot-scale production to the point where the market can be evaluated and the probable costs of full-scale production can be estimated. The export of crops is increasing much faster than the products of pastoral agriculture, the annual growth rate being 10 percent over recent years. The changing balance of our export markets will call for increasing changes in research emphasis to increase the range of products from our primary industries.

Meat production

PASTURE QUALITY AND ANIMAL GROWTH — For a number of years Applied Biochemistry Division, in collaboration with Grassland Division and Massey Univerity, has been conducting trials to evaluate different pasture species using sheep weight gains as an index of feeding value. The aim of the project is to determine and discover reasons for differences between common or new pasture species and to supply information to plant breeders to enable cultivation of strains with improved characteristics and capacity to produce faster animal growth. One clearly established result of this work is that legumes in general, and white clover in particular, have a higher nutritive value than other pasture species. Current trials are emphasising comparisons between leguminous and other pastures.



The tenderness of frozen meat depends greatly on the way the carcass is treated before freezing. Research on this at the Meat Industry Research Institute has aroused worldwide interest. *Photo: National Publicity Studios.*

Of particular interest at present is sainfoin, a highly palatable pasture species, which also has a high tannin content. Tannins in pasture fix protein and inhibit bloat. Efforts are now being directed to the possibility of breeding tannin into some of the more important pastures such as white clover, the major pasture species in New Zealand responsible for bloat.

MUTTON ODOUR — In 1970 Applied Biochemistry Division began research on the chemistry of mutton flavour – a project which could ultimately make sheep meats more attractive to potential customers. The first stage of the project has been concerned with the identification of the compounds in the odour which make mutton disasteful in many countries. A sweaty odour component has been implicated, attributed to the presence in sheep meat of trace amounts of medium-chain volatile fatty acids. Other volatile constituents possibly implicated in mutton odour are under study. The research has been aided by the purchase of a combined gas chromatograph/mass spectrometer with the help of a grant from the New Zealand Meat Producers' Board.

Meat processing

The Meat Industry Research Institute of New Zealand (Inc) recently developed a new method of making frozen lamb more tender – electrical stimulation of the carcass. The results are encouraging, and indicate that it may be possible to attain meat tenderness previously achieved only after lengthy treatment in conditioning rooms. DSIR has provided engineering assistance to develop the process from a laboratory scale to full industrial scale. The results of a series of full-scale trials on units designed and built to fit a chain in a meatworks suggest that the process can replace the need for costly conditioning rooms where the kill is hung before being frozen for export.

The meat industry is both labour-intensive and seasonal, and it is hoped that automation, which has reduced costs in many other industries, can reduce costs here also. The Physics and Engineering Laboratory has developed equipment for the automatic weighing and grading of sheep meat carcasses, and which records all grading information in a form compatible with computer input devices. The equipment, which was operated successfully on a slaughter chain for a complete season, is now being manufactured under licence. As a result of the trial, it has become obvious that there is much wider scope for the introduction of automation into meatworks than has been exploited so far, and that, if the grading information could be linked directly to a given carcass, it would be possible to direct the carcass automatically to the correct rail on the cooling floor.

To prevent lamb carcasses from opening out during freezing, it is common practice to loop a string across the forelegs. Pre-cut and pre-knotted loops were made on machines, many of which were old, slow, extremely noisy, and incurred high maintenance costs and excessive down-time. Christchurch Industrial Development Division (CIDD) has designed a new machine to cut and knot a loop of predetermined size, and then link it in a chain with the previous loop. The entire chain is then rolled on a spool for easier dispensing.

Wool processing

DSIR collaborates with Wool Research Organisation of New Zealand (Inc) (WRONZ)t o carry out research in fields where the Department has special expertise. For many years about two-thirds of export wool bales have been packed in jute, and one-third in locally grown New Zealand flax. In recent years, other woolpacks have become available, and Chemistry Division has collaborated with the New Zealand Wool Board and with WRONZ in trials of, for example, polyethylene, polypropylene, and cardboard. Chemistry Division has assisted the Wool Board in writing a specification for polyethylene woolpacks which is now used as the basis for purchasing.

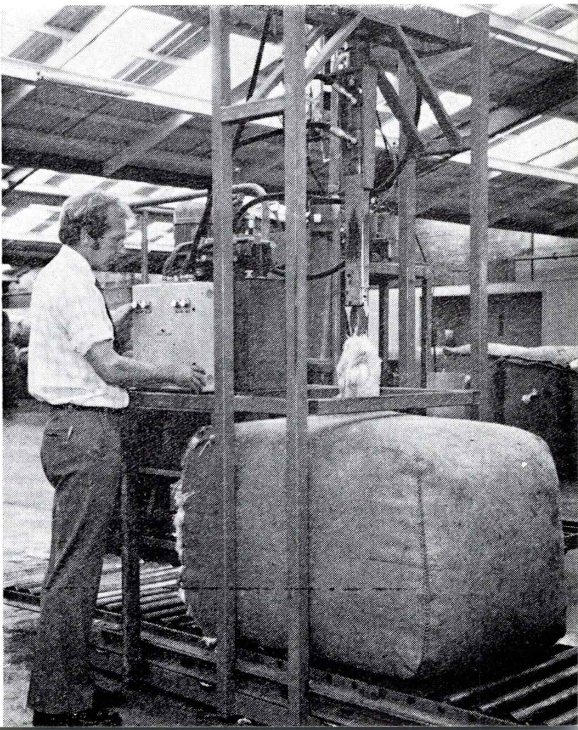
Towards the end of 1970 the Wool Research Organisation drew attention to the rapid growth of the wool-scouring industry, and suggested that technological progress in the scouring process might be improved by applying the conventional techniques of interfirm comparison. Assistance was sought from the Management Advisory Service of the Physics and Engineering Laboratory whose industrial engineers have since worked closely with WRONZ and with scouring plants to demonstrate the benefits to be gained from improved process control. Interfirm comparison is a technique by which common operating ratios of production and cost are recorded by individual plants, and then compared confidentially with the ratios of other plants.

Laboratory and pilot plant studies on the recovery of wool-grease from woolscour effluent using an alcohol solvent have been successfully completed. Design work is under way on the first commercial plant to be installed at Sawyers Bay, Dunedin. Grease and detergent removals of over 90 percent are obtainable, the detergent being recycled for re-use. This research, if commercially successful, will contribute to a pollution-free environment, while recovering lanolin, a valuable natural product that would otherwise be wasted.

The annual costs of shipping New Zealand wool to overseas customers are increasing, and are taking an increasing proportion of the money earned in sales. Wool is a bulky commodity that occupies a relatively large volume for the weight shipped. Studies of the behaviour of wool during compression and release demonstrated that 500 tonne presses can make smaller bales than those made by the present 100 tonne presses. This means that less shipping space will be required for wool transport, with a consequent saving in costs.

International standards exist to recognise the presence of 16 percent water in scoured wool, and shipments can be certified to adjust weights to conditioned weights. No such agreements exist with slipe wool, where as small a water adjustment as 3 percent can represent abut $1 million p.a. to New Zealand. Moreover, it is desirable for certified scoured bales to have weights close to their conditioned weghts. Chemistry Division developed a very rapid analytical method of controlling the commercial drying of wool, enabling shipments to be made with the correct conditioned weight. CIDD has developed a new technique of core boring so that analytical samples can be taken from highly compressed bales.

Grab-sampling of wool bales reduces handling costs by eliminating the need for bales to be "show-stacked" for buyers' inspection. Wool Research Organisation is investigating the representativeness of the samples taken from wool bales by sampling machines built in New Zealand to a modified Australian design.



Almost since its inception, the New Zealand wool trade has been plagued by outbreaks of spontaneous ignition in baled wool. As a result of many disastrous shipboard fires in wool cargoes a Public Inquiry was held in 1894, and in 1906 a Royal Commission of Inquiry investigated spontaneous ignition of both flax and wool. These difficulties continued until 1949, at which time spontaneous outbreaks of fire were occurring in about two freezing works and one wool-ship every year. Collaborative research between the freezing industry and DSIR then demonstrated that the trouble was being caused by pie wool, and a new method was developed to remove wool from skin pieces ("Slipemaster"). As a result of this work, spontaneous fires no longer hamper the wool export industry.

The use of crossbred wool in semi-worsted yarns for making tufted blankets and various knitted items such as socks, heavy outerwear, and knitting yarns has been continued. The processing of this wool on the self-twist system has been advanced, and yarns have been used for making carpets with attractive unusual appearance. The use of variegated yarn in blankets and carpets is being further explored. A number of these developments are now semi-commercial or fully commercial.

Polymer treatment of wool for use in carpets has been satisfactorily carried out on a mill scale. Polymer-treated wool is also being used in a quite different application for water purification.

Flameproofing is of increasing importance, and several applications have been developed, especially for use in aircraft. The effect of light on wool is being examined with a view to decreasing the degradation which occurs in curtains and other furnishings. Prevention of development of static in carpets is also being actively pursued.

Dairy processing

DSIR collaborates with the New Zealand Dairy Research Institute on various projects such as use of a computer to control evaporation and spray-drying of milk, so that efficiency of operation and of energy use is maximised (subject to the restrictions imposed by the need for a product of specified quality). One important objective of the project is to demonstrate the feasibility of computer control in processing industries based on primary produce, many of which are very labour-intensive.

MECHANISATION OF CHEESEMAKING — Cheesemaking was the "Cinderella" of the dairy industry until quite recently. The traditional process was both arduous and labour intensive, and at the same time not as amenable to modern standards of sanitation as could be desired. Recognising these problems, the New Zealand Dairy Research Institute undertook a research and development programme to mechanise the process and overcome the other problems.

The significance of each step in traditional cheesemaking was investigated and the associated man-hours and physical effort were measured. As the first half of the process was critical to cheese quality and required little labour, the mechanisation programme was initially concentrated on the second half of the process, and on pressing. This resulted in the Cheddarmaster system, which deals with separation of curd and whey, cheddaring, salting, and mellowing. From this work also the Large Hoop system of pressing was developed, whereby about one tonne of curd is pressed into a single block which can then be subdivided into 20-kg blocks, the size produced by traditional means of pressing. When this equipment was going into commercial use, work began on an enclosed vat which requires much less floor space than its traditional counterpart and is amenable to mechanised, in-place cleaning. By the end of 1975 some 70 percent of all cheese made in New Zealand was made with Cheddarmaster equipment. The largest cheese factory in the world (Bon Conseil, Canada) is using the system, as are the largest factories in Europe (Carbery, Eire), Britain (North Tawton), and New Zealand (Whareroa). Most of the equipment used overseas for mechanised cheesemaking has been made in New Zealand, and exports of Cheddarmaster and allied equipment have a value in excess of $5 000 000.

The objectives of the development programme have all been met: arduous work has been eliminated, cheese manufacturing costs have been reduced, the output of a given size factory has been considerably increased, and hand cleaning has been almost eliminated.

CHEESE STRUCTURE — Cheshire, Cheddar, and Gouda cheeses were studied by the Physics and Engineering Laboratory in co-operation with the New Zealand Dairy Research Institute to determine whether the sub-microscopic cheese structure is related to macroscopic properties and to manufacturing conditions. The results showed that the milk fats in cheese are mostly in the form of globules in Cheshire and Gouda; but the globules are deformed and ruptured in Cheddar cheese. It was shown that the protein structure of Cheshire is less organised than in Gouda. Since their milk-fat distribution is similar, this may account for differences in their texture.

CASEIN — Casein is a phospho-protein, widely used in experimental nutrition as a protein source in semi-synthetic diets, and in formulating baby foods. It is usually highly regarded because it is a good source of essential amino acids, rather than because it is a phospho-protein. However, recent studies have shown that this characteristic as a phospho-protein has unique dietary importance in promoting detoxification of certain liver poisons. A series of studies is under way to determine the fate of the phosphorylated components of casein during digestion, absorption, and metabolism.

Other agricultural products

Annual exports of live animals, pelts and hides, honey, eggs, and other agricultural products earn over $100 million. DSIR carries out research on these agricultural products. For example, DSIR assists the export trade in race horses with an inspection service using infra-red scanning to detect disease or injury in the horses' legs. A horse having such a defect will show a small rise in skin temperature in the affected part after exercise, which is detected by an infra-red camera. This evidence helps a veterinarian to decide whether a horse is sound or not, and can indicate defects that would otherwise escape detection. The high cost of racehorses plus the costs of air freight make a guarantee of perfect health essential, and a similar examination is often made on arrival overseas.

Most honey-importing countries demand conformity with international specifications for natural honey. Chemical tests can detect if honey has been adulterated with sugar, and DSIR tests honey and honeydew to demonstrate that they are pure, thus facilitating export to countries like Germany and Japan. Other tests can detect toxic materials in honey or honeydew, derived from deposits on the leaf of tutu. These materials can cause convulsions and excitement symptoms in humans.

A tannery desired identification of sheepskins during tanning as part of their normal quality-control procedures. They had attempted hand-punching of holes in the skins to imprint codes. Christchurch Industrial Development Division investigated complex techniques such as tattoo machines and high-pressure liquid jets, but finally reverted to a modification of the original process. By using a pneumatic piston to drive spikes through the skin backed against a rubber block, codes could be imprinted to survive tanning. Design sketches and cost estimates were provided to the firm, who are now considering adopting the process.

FORESTRY AND FOREST PRODUCTS

Soil surveys in beech forests

Early Soil Bureau studies of the nutrition of hard beech have proved valuable in assessing the impact of the New Zealand Forest Service plans for utilising the South Island beech forests. Since 1972, soil surveys of approximately 500 000 ha carried out in North Westland and Buller show a complex pattern of soils, with mixed parent materials being a common feature of much of the hill country. Soil maps at a scale of 1 : 50 000 have been published for the Inangahua Depression and are being prepared for other surveyed areas.

Improved methods of appraising soils for forestry potential, which will permit more accurate assessments of site limitations to exotic forest growth, are being used. These methods include nutrient balance sheets, and a qualitative rating scale which assesses physical and chemical limitations of different soils. These assessments are based largely on morphological and chemical soil properties with added information obtained from more general considerations such as site characteristics.

Most soils being considered for utilisation by the New Zealand Forest Service are of low fertility and will require fertiliser applications for long-term production. Also most soils have one or more physical limitations, such as potential erodibility or a restricted rooting volume, which will have to be taken into account in planning exotic forestry.

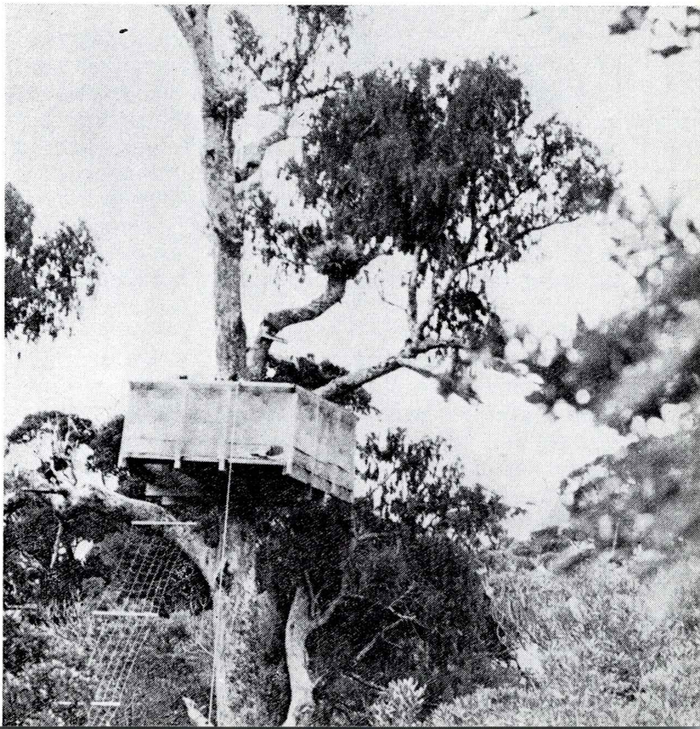
Animals of beech and pine forest litter

The animals, particularly arthropods, in leaf litter and other organic horizons of a beech forest and an adjacent 4-year-old *Pinus radiata* stand near Reefton have been compared by Soil Bureau. These animals break down plant and animal remains. Beech litter had a rich and varied fauna, but there were few species and low numbers of animals in the pine litter. Certain groups common in beech litter (e.g., weevils) were absent from pine litter, and others (e.g., millipedes, centipedes, spiders, ants, beetles, beetle larvae, and caterpillars) were poorly represented.

Burning before planting with pine destroys much of the litter and other upper organic horizons of the original forest soil, and it appears that most of the animals are killed. Any that remain have no food or shelter and soon die. Occasionally, however, small deep pockets of organic matter from the original forest were found in which some animals had survived and were breeding.

Opossums in native forests

A major part of Ecology Division's research in the Orongorongo Valley has been a study of population ecology of opossums and their effects on the forest. The opossum is now considered to be the most damaging of the browsing noxious animals in native forests and probably the most difficult to control. A recent study in the Orongorongo Valley has shown that about 60 percent of the opossums' leaf diet is of tree rata and kamahi, both of which are being killed by browsing. Fuchsia and titoki, preferred species there in the late 1940s, are now rare. This could well be the eventual fate of rata, kamahi, fivefinger, tawa, and taro. Reasons for this selection of particular species are being sought in feeding trials with captive opossum. First results suggest that toxic or secondary compounds in the leaves may be responsible. It may now become possible to predict change in the composition of native forests in the presence of opossum, and so to assess the need for controlling them.



Damage to native forests by opossum browsing is studied by scientists of Ecology Division. Behaviour of the animals is observed from platforms such as this one in the Orongorongo Valley, near Wellington.

DSIR has helped in the establishment of the Logging Industry Research Association, which is developing costing systems for logging and transport contractors, and evaluating equipment such as power-saws, tree-shears, and safety helmets. *Photo: National Publicity Studios.*

Climate room – pine seedlings

Field observations have shown that the degree of frosting damage to young pines depends both on the severity of the frost and the season in which the frost occurred. Seedlings and rooted cuttings were collected by the Forestry Research Institute from several North Island nurseries and subjected to frosts in the climate rooms, enabling the effects of plant age, season and nursery location to be examined.

Planting stock sampled in winter only usually suffered severe injury at approximately −10°C, although 60 percent of the plants collected in Northland were killed or severely injured at −6°C. Critical temperatures for spring-sampled plants were between −6°C and −10°C.

Forest products

At present there are over 600 000 hectares of merchantable exotic forests, and these are being increased at a rate of 17 000 hectares per year. Approximately 15 million cubic metres of timber, 600 000 tonnes of pulp and paper, 3 million square metres of particle board, and 45 000 tonnes of fibreboard are produced annually. In 1972, the value of exported forest products was $82 million.

Working in close collaboration with the New Zealand Forest Service, DSIR has been involved with research on forest products since the original radiata pine logs were sent to Texas for pulping trials some 30 years ago.

The physical and mechanical properties of wood have been investigated in the Physics and Engineering Laboratory using electron microscopy to study the fine details of cell structure. The studies show that the wood cell is an orderly framework of cellulose strands embedded in a structureless bonding medium – somewhat akin to fibreglass reinforced resin. Using this knowledge, it was possible to build a theoretical "model", or a mathematical picture, of the bonding forces between molecules in the cell wall. The model has been used to predict shrinkage behaviour and the elastic properties of wood, especially *Pinus radiata.*

Waste utilisation

Sawdust and bark are waste materials for which little use has yet been found, although some sawdust is used for pulping. They may be burnt to raise steam, but this can cause a smoke nuisance, so Auckland Industrial Development Division has devised a special burner that overcomes the smoke problem. Pine timbers contain various essential oils of commercial value which can be recovered in the course of "Kraft" pulp manufacture. Cooperative research between Chemistry Division and a pulp and paper company established a commercial extraction process, now producing turpentine and tall oil. DSIR is studying the chemical components of bark in an effort to discover further economic by-products and uses. Work is under way with the aim of producing resins and wax from *Pinus contorta* and Douglas fir bark, for use in glues, polishes, and cosmetics.

Paper and cardboard

In the manufacture of writing papers, filler clays are incorporated to provide the necessary firm, smooth surface. It was found that writing papers made with local filler clays rapidly blunted guillotine blades in the paper-processing plants, and research to solve the problem established conditions for pulping and clay refining to minimise this difficulty. Production of writing and typing papers with local clay is now worth about $7 million annually, through savings in imports and through exports.

Some of our agricultural produce is exported in cardboard containers, and it is important that the cardboard should not contaminate the contents. Chemistry Division has analysed a wide range of local cardboards for purity, and has shown that papers and cardboards meet the import requirements of our customers. Unexpected problems arose in recycling paper products, for example some of the filler pulps used in the manufacture of cartons were found to contain toxic polychlorinated biphenyls, but DSIR work has helped eliminate this contamination.

MINERAL PRODUCTION AND PROCESSING

Huntly coal

The world increase in the price of petroleum has made oil an expensive fuel for energy generation. Consequently many countries are re-examining their fuel resources, especially coal, for possible use as a cheaper source of energy.

In New Zealand an intensive survey to find, by mid-1977, 200 million tonnes of coal for use in proposed coal-fired electricity generating stations, was started in the Huntly area by Mines Department in 1975. Because the coal-bearing rocks in the Huntly Coalfield lie at depths of between about 75 metres and 600 metres, an intensive drilling programme, requiring about 300 holes, is needed to discover if coal is present in workable thicknesses. Geological Survey geologists are assisting in this programme, assessing the lateral persistence of the coal seams and calculating the quantity of coal present. Drilling has so far shown that coal is present to the north and north-east of the present mines at Huntly West, but at greater depths. The investigations are not advanced enough to confirm the presence of an adequate quantity of coal.

Highlights of the petroleum search

Close collaboration between DSIR and industry, with the oil companies using scientific records of Oceanographic Institute, Geophysics Division ,and Geological Survey, led to the discovery of the Kapuni and Maui strikes. The progress of the Maui well was monitored by Geological Survey examination of microscopic fossils in the drill cuttings.

Natural gas from the Kapuni field has been distributed in New Zealand since 1970. Gas sales have exceeded all expectations, with annual growth rates of 20 to 40 percent. Maui has reserves of gas estimated to be 10 times larger than those of the Kapuni field, and these reserves will ensure that natural gas plays a very significant role in satisfying energy demand in New Zealand over the next quarter century.

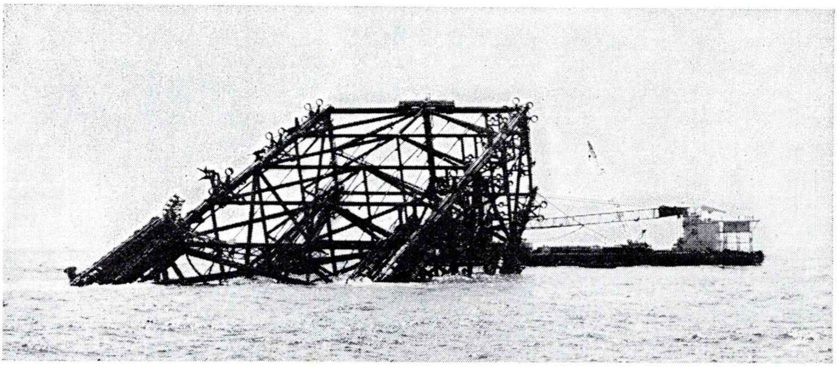
Exploration efforts by oil companies have now reached an all-time high. Based on extensive marine geophysical surveys, offshore drilling is carried out continuously by two floating rigs operating in different areas; at least 10–12 wildcat wells have been planned, regardless of their outcome. Geological Survey is assisting in the stratigraphic control of such wells, based on micropaleontological fossil determination. Other services such as examination of cores and cuttings, and radiometric age-dating by the Institute of Nuclear Sciences, are provided when required.

With the Government entering into participation agreements with several oil companies, Geological Survey's Petroleum Section is increasingly committed to give advice to the Ministry of Energy Resources on questions of work proposals, drilling locations, and supervision of drilling operations. Close co-operation with Mines Department for the assessment of applications and issue of licences is continuing; on behalf of the Mines Department, Geological Survey stores and studies all reports and records submitted by oil companies under the Petroleum Act. With supplementary finance from the New Zealand Energy Research and Development Committee, allowing for a rapid expansion of the

Geological Survey's examination of microfossils in drill cores and radiometric dating provided by the Institute of Nuclear Sciences have been substantial DSIR contributions to the offshore search for oil. The upending of a drilling platform on a prospecting site earlier this year is shown in these photos.

Photos: Shell BP Todd Oil Services Ltd.

Petroleum Section, DSIR is evaluating the petroleum potential of young sedimentary basins over the whole New Zealand region on- and off-shore. Results of this study will provide a basis for the assessment of energy resources, and assist Government in defining its policies with regard to petroleum search and participation.



Kapuni model

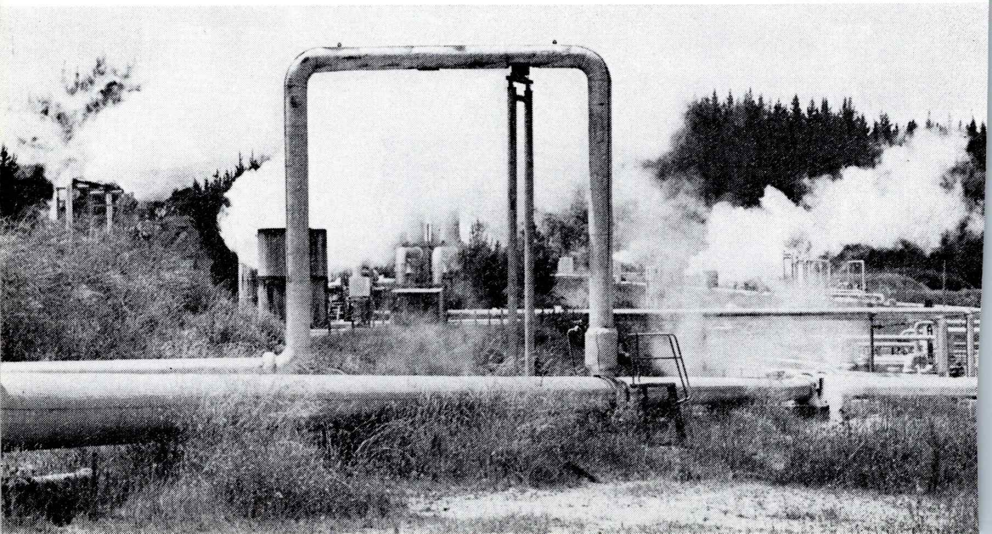
Mathematicians at Applied Mathematics Division have produced a computer "model" of the Kapuni natural-gas field. The model accurately reproduces the rather irregular shape of the field, and, when supplied with the known gas draw-off over a two-year period, generated curves for the individual wells which agreed well with field measurements. From the model, it is possible to predict the future response of the field under various draw-off schemes, and to calculate the changes that would result from drilling new wells.

Geothermal steam

New Zealand is among the world leaders in the development of geothermal power. Scientists from many disciplines and DSIR divisions were involved, together with colleagues from the Ministry of Works, in the detailed investigations at Wairakei that led to its present production of 150 MW of electric power. Many other areas have been surveyed, from Tokaanu to Tikitere, and holes have been drilled at half a dozen sites. A resource assessment at Broadlands has shown a potential of at least 100 MW, and further exploration is likely to show similar potential for several more stations. The Kawerau field produces the equivalent of about 25 MW of steam, principally used in industrial processing in the local pulp and paper mill.

More recent work has been on the possibility of improving the efficiency of use of steam at Wairakei and prolonging the life of the source. Scientists at Applied Mathematics Division and Auckland Industrial Development Division have constructed mathematical models to try and indicate the characteristics of the thermal source. When an accurate model is obtained, the calculations necessary for efficient management of the field can be done easily by computer. Similar studies are being made of the Broadlands field.

Expansion loop, Wairakei geothermal field. Steam from the field, developed with DSIR scientific assistance, is used to generate 16% of the North Island's electricity.



In addition, Physics and Engineering Laboratory have looked at the possibility of using minerals carried up in the steam and at present wasted. A pilot plant for the recovery of commercial calcium silicate products from geothermal bore water has beeen tested by Chemistry Division at Wairakei and Broadlands, and drying tests and commercial evaluation of the products are in progress. It was found that during some conditions of precipitation of calcium silicates the arsenic content of discharged waters can be reduced to acceptably low values; pollution control considerations are therefore accelerating the development of this process. The success of the Kawerau development of steam for industrial purposes, the more recent production of sulphur at Rotokawa using geothermal steam, and especially the long-standing and most recent uses of steam at Rotorua show the value of looking hard at future industrial usage for purposes other than power. Geothermal steam may well become a most effective means of direct use of energy, because relatively small fields can be exploited directly, and these could include areas away from the well-known Rotorua-Taupo region.

Rotokawa sulphur

With the assistance and co-operation of DSIR and the Ministry of Works and Development a company has been producing sulphur by both Frasch bores and autoclaving, making use of geothermal steam from a Rotokawa geothermal bore. The surface mining of sulphur ore at the northern end of the lake is being used to produce feedstock for the autoclave and to produce a +50 percent sulphur pumice mixture for direct broadcasting on farmland.

The sulphur extracted so far, though in uneconomic quantities, is of high grade and has been sold to a fertiliser company for sulphuric acid manufacture.

Ironsand processing

Chemistry Division has demonstrated that metallic iron can be produced very rapidly directly from fine ironsand concentrates plus fine coal in a very small, continuously operating pilot reduction plant. Optimisation studies are in progress to increase the throughput and lower the energy consumption to commercially useful levels.

Research is also in progress aimed at the economic recovery of titanium and vanadium in commercially saleable forms from ironsand smelting slags.

Shell moulding sands

The recently developed foundry "shell moulding process" uses quartz sands bonded with synthetic resins to produce shell-shaped moulds about 10 mm in thickness for the production of metal castings. The moulds produced have advantages over conventional clay-bonded sand moulds in that smaller quantities of sand are required, the shell moulds can be stored indefinitely without deterioration, and castings can be produced with improved surface finish and consistently close dimensional tolerances.

Until recently, the sand used for shell moulding was imported mainly from Australia. However research and development work by

Chemistry Division, in collaboration with industry, has shown that New Zealand silica sands can be successfully used for commercial shell moulding. The industrial production and successful use of resin-coated sands of local origin is increasing steadily, with consequent annual savings of overseas funds for importation of equivalent materials worth $100 000.

Industrial chemicals from Christmas Island C phosphate and seawater

In 1969 a process was developed at Chemistry Division for extracting smelter-grade alumina and very pure trisodium phosphate from Christmas Island C Phosphate, a previously unusable mineral resource, but the process was marginally uneconomic at 1970 prices.

In 1974 a project to use waste heat from the proposed gas-fired Auckland 1 electricity generating station to evaporate seawater was begun with the aim of producing industrial salt. Seawater contains considerable amounts of magnesium as an impurity, and if trisodium phosphate is mixed with concentrated seawater, it simultaneously purifies the salt and gives a cheap, pure source of magnesium. The magnesium ammonium phosphate was converted into fluorine-free magnesium phosphate, for which there is a large, high-value market overseas as a cattle-feed supplement.

Chemistry Division is therefore now proposing an integrated scheme, where Christmas Island C Phosphate (essentially a waste-product) and seawater can supply alumina, aluminium sulphate, magnesium phosphate (for export), salt and chemicals derived from salt, such as sodium carbonate, sodium hydroxide, sodium sulphate, and chlorine. This scheme is being supported by industry and the New Zealand Electricity Department, who may incorporate such a chemical industry (with large export potential) into their design of the Auckland 1 power station.

Glauconite from Chatham Rise

Glauconite is a hydrated, iron-rich micaceous clay mineral that forms exclusively in the marine environment by the absorption of potassium and iron into certain pre-existing minerals. The potassium content of the glauconite is commercially interesting, since it has been demonstrated overseas that soils formed naturally upon glauconite-bearing strata are often remarkably fertile.

Small quantities of glauconite are widely dispersed in some sedimentary formations of New Zealand and in unconsolidated surface sediments of the New Zealand continental shelf. On Chatham Rise, however, there are extensive concentrations of glauconite on the sea floor, in which the mineral constitutes more than 50 percent (and locally approaches 100 percent) of the bottom sediment. These deposits lie in water depths less than 500 m, and, with modern advances in ocean mining technology, could be relatively easily recovered.

While it is doubtful that glauconite could compete directly on the world market with existing supplies of potash, it may have an important role to play, as a possible source of slow-release potash for agricultural use, thus solving the problems of pollution of our rivers and lakes. Pot trials are being conducted at Massey University, in collaboration with

New Zealand Oceanographic Institute, to assess the suitability of Chatham Rise glauconite for agricultural application.

Hutt Valley groundwaters

The waters of the Hutt Valley–Port Nicholson groundwater basin are one of the major sources of water in the Wellington region. Wells tapping the aquifers of this basin supply the municipal needs of Lower Hutt, Petone, and Eastbourne, and supplement the Wellington City supply. Other wells supply the needs of many of the major industries of the Hutt Valley. It is therefore of considerable importance that the operation of this groundwater system be fully understood, and that those responsible for managing this resource have the means of assessing the effects of various demands upon it under a wide range of circumstances. The Physics and Engineering Laboratory has recently completed a very successful computer model study of the Hutt Valley aquifer.

Under normal operating conditions, water levels in the non-artesian zone are correlated with river levels while in the artesian zone the waterheads are predominantly controlled by the withdrawal of water from the wells in this region.

At times of drought, water is withdrawn from storage, from the non-artesian region. The limit on withdrawal from this reservoir is, however, dictated by the dropping pressures around the withdrawal wells, and under extreme conditions these pressures can fall so much that saline water from the harbour could conceivably be drawn into the aquifer system.

During the dry spell in early 1973, pressures at the southern end of the valley were sufficiently low that storage reserves of the aquifer beneath the harbour were used, but a small flow into the harbour was maintained; i.e., there is no evidence that saline water from the harbour would have been drawn into the aquifer.

In addition, surveys were made by Geophysics Division in both the Lower and Upper Hutt Valleys between 1960 and 1963, with measurements extending into the greywacke hills both to the east and the west to fix the regional variation of gravity, and to permit more accurate separation of the small effects due to the lighter sediments within the valley. To complement the gravity data, seismic refraction profiles were measured in 1962 and 1963 in the area of the Taita Gorge and across the Petone foreshore. Interpretation of this information has yielded a series of profiles showing depth to the impermeable greywacke basement, and has given the third dimension from which the volume of the ground water reservoir could be estimated, as well as a guide to the maximum depth to which water wells could usefully be drilled at various points. These studies establish the optimum pattern of bore sites and the maximum depth to which water wells could be drilled.

Groundwater, Pacific Islands

The Pacific Islands closely associated with New Zealand have special problems in obtaining enough water for their increasing populations and to service modern agricultural techniques. In general, whether the islands are volcanic or coral, they have natural surface reservoirs in which water can be collected or stored. High permeabilities in the rock allow the water to percolate rapidly downwards to build up a freshwater lens. Water for human and agricultural use has to be obtained from this lens, and the lens must not be exploited to the extent that saline water is drawn into it.

DSIR's contribution to groundwater use in the islands consists of geological advice and drilling assistance. Geologists assess the nature and distribution of the rocks and, taking into account other factors such as topography and population density, attempt to determine the most suitable places for drilling. Such advice has been provided to Cook Islands, Western Samoa, and Tonga through New Zealand or other aid programmes. Much of the water in the islands is obtained from hand-dug wells; though some form of antique drilling equipment exists on the larger islands, it is usually unsuitable or unserviceable. The department's team of drillers, though small, has a wide and varied experience and can give advice, assume technical control of contract drilling, or give direct drilling assistance. During 1975, in Tongatapu, one of DSIR's rigs with two operators drilled ten production wells and three wells for monitoring the quality of the water, taking only two months to complete the task. The department is providing geological and technical control for a programme of ground water drilling in Western Samoa.

MANUFACTURING

Metrology

The National Standards facilities at the Physics & Engineering Laboratory (PEL) are the basis of precision measurement in New Zealand, and they are being rapidly improved and upgraded as the industrial development of New Zealand calls for measurement of greater and greater precision.

The Department's ability to measure accurately is consistently used in the service of industry and Government. Measurements for industry range from the very sophisticated to quite elementary measurements made "on site" to correct some quality control breakdown. Examples include precision measurements on tools and gauges; measurement of surface finish; gauge calibration; alignment of large machine tools; calibration of testing machines; measurements to determine causes of failure of metal components; analysis of material composition; testing of products to specification; calibration of electrical equipment and testing of electrical components; testing of lighting fittings; and non-destructive testing of all types.

It is important that the "working standards" of other laboratories are calibrated in terms of the National Standards at PEL at suitable intervals depending on the particular class of measurement and measuring equipment. It is because of this need that DSIR first pressed for the formation of the Testing Laboratory Registration Council (TELARC) in this country. Calibration and regular recalibration of equipment will be an important condition of registration by TELARC of a testing laboratory .

The existence of accurate national standards of physical quantities and of good measuring facilities in DSIR, and the formation of TELARC, are vital for continued industrial development.

Steel production

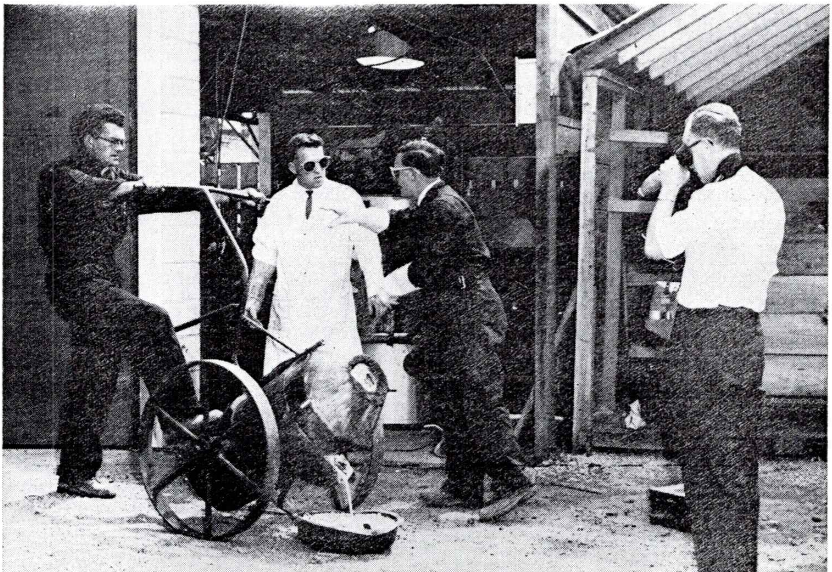
Attempts to produce steel in New Zealand date from soon after 1840, when settlers first saw the potential of ironsand beaches in New Plymouth. Over the years, numerous experimental and commercial attempts to produce steel from ironsands, Onekaka limonite ore, or scrap steel met with no lasting commercial success, until systematic research and development work was started by the New Zealand Steel Investigating Co. Ltd in 1960.

DSIR involvement can be dated from 1949, when extensive exploration showed that major resources of ironsand were available, and successful electric smelting tests at Onekaka confirmed the technical feasibility of producing steel from it.

From 1956 to 1960, co-operation with other government departments and industry led to the establishment of Pacific Steel Ltd for secondary steel production from scrap in Auckland, and of the New Zealand Steel Investigating Company Ltd to study the feasibility of major primary steel production in New Zealand.

This resulted in a major involvement by DSIR in systematic investigations. Officers were seconded to the investigating company for varying periods. The Dominion Laboratory (now Chemistry Division), Geological Survey, and Geophysics Division did major work on exploration, mineral processing, and metallurgy in co-operation with the overseas consultants appointed by the company. After this the Government

The use of New Zealand ironsands for steelmaking has been the subject of numerous experiments by DSIR with other Government departments and private industry. This photograph shows molten steel being examined by a visual spectroscope after a pilot-scale smelting experiment.



adopted the Investigating Company's recommendations for phased establishment of steel production from ironsand, and New Zealand Steel Ltd was formed in 1963.

Major kiln operating problems were encountered when production started, but were overcome by the company's own technical staff, with only minor assistance and advice from DSIR, and steel is now being successfully produced from indigenous ironsands and coal. Further expansion of the operations, following the stages recommended by the Investigating Company could produce a major proportion of New Zealand's steel requirements, plus a modest amount of steel exports.

DSIR involvement is continuing with basic research to improve ironsand reduction and smelting technology, research on the recovery of vanadium and titanium from waste steelmaking slag, and with assistance in the systematic recovery of scrap steel from automobile and municipal wastes for recycling to the steel plants. All of this research is aimed at maximising the efficient utilisation of New Zealand resources, and minimising waste disposal problems related to the significant and growing New Zealand steel industry.

Quality control in the textile industry

A request from a prominent textile manufacturer to Auckland Industrial Development Division for general assistance with plant technology has led to valuable improvements being applied to control of buying specifications, management technique, and methods of testing. This success was followed by requests from other textile manufacturers to review their production methods.

With one manufacturer, AIDD showed that specifications relating to the "loom-state" of bought-in materials from overseas suppliers were too lax: weight of material, twist on the yarn, colour, amount of filler, shrinkage, and strength all play a vital role in the end use.

Similarly, a clothing manufacturer was almost unaware of the properties of the large quantities of man-made fibre being used in his garments, and because correct melting and softening temperatures for the fibre had not been obtained from the overseas supplier, haphazard application of temperatures had been producing undesirable attributes in made-up garments. These defects were remedied when the platens in the clothing presses were adjusted to the correct temperature.

Another large user of imported base fabrics had also been experiencing difficulties in obtaining consistent quality from overseas suppliers, largely because of vague purchasing policies. Help has been provided with the upgrading of testing methods and procedures, and new methods have been proposed for their purposes.

These AIDD case histories show that the technology of a process can often be improved simply by obtaining suitable advice and not necessarily with large capital outlay; and the price of quality assurance at the various stages of manufacture (from purchase of raw materials onwards) is slight compared with production losses caused by, for example, bolts of sub-standard cloth having to be returned to an overseas supplier.

Metallurgical work

The detection of metal fragments in foodstuffs is an important part of quality control. One example of work undertaken by Christchurch Industrial Development Division was the design and manufacture of two metal detectors for a freezing works packing tongues for export. A low operating frequency was chosen because of the electrolyte in the tongues, and an automatic balancing system was incorporated. The smallest particles that could be detected were 1.5 mm lengths of 0.25 mm steel wire. Because the detection of such particles depended on their orientation, the efficiency of the first detector was increased by mounting deflector plates, which tumbled the tongues, allowing the detector to obtain two "views" of the objects passing through the coils.

DSIR maintains metallurgical laboratories, and will investigate metallurgical failures for industry. Typical problems on which advice has been given include quality control of the hardness of tips of stainless steel hooks for meat; failure of drive gears in rendering plant; failure of drier shafts; cracking and failure of cast-iron meat-hook carriers; and corrosion failure of stainless steel water tanks and other equipment.

Agar

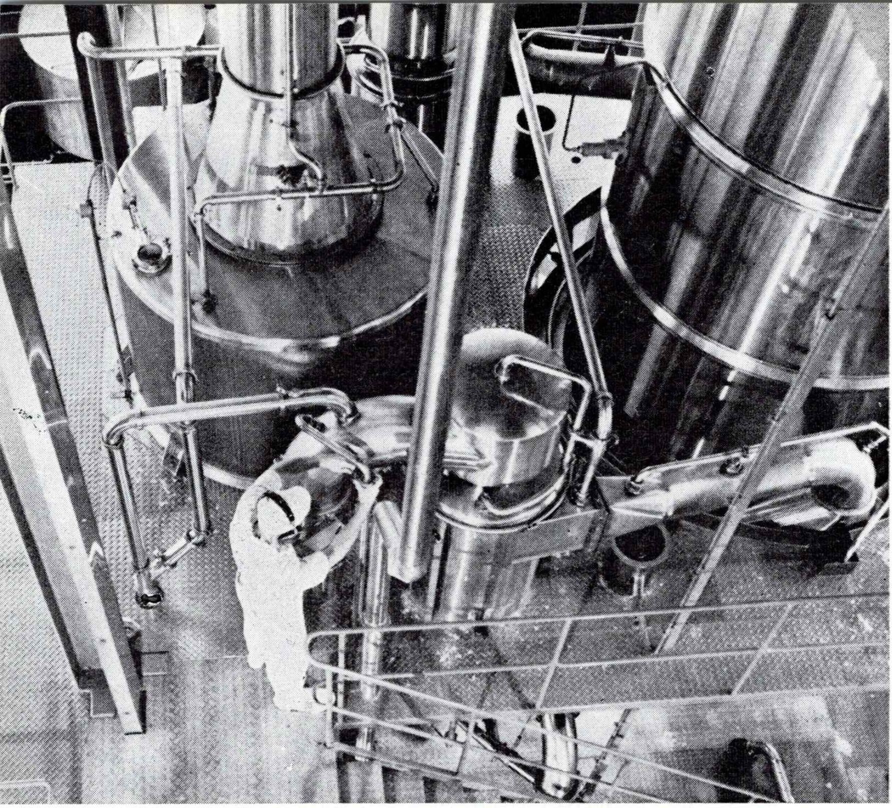
New Zealand has a successful industry extracting agar from seaweeds, based on research by industry and by DSIR. To further assess the potential value of New Zealand's seaweed resources to support industries based on extractives from seaweed, an algologist at Botany Division is surveying the distribution and abundance of various seaweed species. Research has been started at Applied Biochemistry Division to explore the levels in certain red seaweeds of the poly-saccharide carrageenan, which has gelling properties useful in the food industry.

New bread-making process

For more than 4000 years bread has been made by mixing yeast, water, and salt with flour, and allowing the mixture to ferment for some hours. The dough is then divided into loaf-sized pieces, shaped, and allowed to ferment further for about an hour before baking. Although now largely mechanised, the basic process changed little over the centuries.

However, a few years ago processes were devised overseas in which a short period of intensive mixing could be substituted for the bulk fermentation stage, with savings in time, space, and labour. Wheat Research Institute studied these processes from the beginning, and the work intensified after a machine was installed in a New Zealand bakery in 1965.

Using a small-scale mixer, the institute acquired a satisfactory working knowledge of the process as applied to New Zealand flours. These results were confirmed in commercial bakeries and disseminated to the industry in New Zealand at meetings and by articles in trade magazines. A number of machines are now installed, and many more are on order.



Computer control of evaporation and spray driers in the manufacture of milk powder is being assessed by the Dairy Research Institute. The spray drier shown is being monitored continuously for temperatures, pressures, flow rates, and milk densities.

Spray drying of milk

A major research project to investigate computer control of multi-effect evaporators and their associated spray driers is being undertaken at the Dairy Research Institute, Palmerston North, by the Physics and Engineering Laboratory in association with the New Zealand Dairy Board, the Dairy Research Institute, IBM New Zealand Ltd, and the Department of Industrial Management and Engineering, Massey University.

An IBM System 7 computer unit has been installed and is being used to record data from about 70 instruments which have been, or will be, fitted to the pilot-scale Weigand evaporator and the De Laval spray drier plant. The instruments record temperatures, pressures, flow rates, and milk densities.

A mathematical model has been developed and checked against the actual operation of the evaporator. This model is useful both for control of design and for giving a clearer understanding of the relationship between plant variables. The first phase of the development is now almost complete. Next it is planned to develop systems which will allow all of the essential variables to be controlled. The process will then be capable of regulation more closely to predefined operating levels which can be altered to allow for the manufacture of any type of milk powder.

It is anticipated that by the end of 1976 the project will have reached the stage where advice can be offered to dairy companies on the installation of control systems for evaporators and spray driers. Apart from the value of the project to the dairy industry, the experience gained will be invaluable in advising other food-processing and chemical-processing industries.

Thick-film integrated circuits

Modern electronics is dominated by the technology of integrated circuits, complex devices performing their operations at incredible speeds and with such economy of power that they were beyond the rashest imagination a mere twenty years ago.

Integrated circuits come in two types: monolithic integrated circuits consisting of minute slabs of silicon subtly altered to achieve the required circuit functions, and hybrid integrated circuits, the size of postage stamps, on which the circuits are literally printed and to which transistors and other components may be attached.

The monolithic circuit is only economic when it can be produced and used by the million, and New Zealand with its embryonic electronic industry must for many years buy these circuits from overseas suppliers. The hybrid circuit, however, can be economical in quite small numbers and could be useful to New Zealand electronics manufacturers.

To introduce the technology, the Physics and Engineering Laboratory has recently set up a pilot plant facility to produce thick-film hybrid integrated circuits. Well patronised seminars have been held for the electronics industry; a number of firms have had prototype circuits made in the plant and are now evaluating them. One major company has already decided to set up its own pilot plant, relying extensively on the training and facilities that PEL has been able to offer.

Expenditure of the modest sum required to bring an expert to this country to assist with setting up of the pilot plant, and an equivalent sum to purchase the equipment, has led to the introduction of a new technology to New Zealand, of great assistance to a growing industry, enabling it to keep abreast of overseas designs in the competitive export markets which it is attempting to enter.

Future liquid fuels

At present, fuels for transport make up over 40 percent of total primary energy consumption in New Zealand. These fuels are derived largely from imported oil and cannot be readily substituted by energy resources in other forms. The import bill for oil now exceeds $300 million per year and, because of the high dependence on these imports, New Zealand is very vulnerable to fluctuations in their price and supply.

Chemistry Division has initiated two projects to examine short-term and medium-term alternatives to crude oil as a source of transport fuels, based on indigenous resources. Both of these projects have been supported financially by research contracts with the New Zealand Energy Research and Development Committee.

In the short term there is the possibility of producing methanol from natural gas for use as a gasoline extender. Current research, conducted jointly with the Department of Chemical Engineering at Canterbury University, is concerned with the physical properties of methanol/ gasoline blends. The tendency for the methanol to separate from the gasoline when the blends are contaminated with trace quantities of water is the major problem. Research will be expanded in scope to include static engine testing and road tests.

Calculations indicate that the production of methanol in sufficient quantity to enable blends containing 15 percent methanol to be marketed would yield a net benefit to the balance of payments of about $33 million.

In the longer term there is the possibility of producing synthetic gasoline or crude oil from coal. This could include the production of methanol. Although technology is available for coal liquefaction, it is costly and inefficient. Chemistry Division research is designed to monitor and assess new, more efficient, and less costly processes being developed in the United States. It will also identify those processes and process modifications most suited to the unique properties of New Zealand coals.

It is estimated that new processes will become commercially available in the 1980s. Calculations indicate that an "oil from coal" plant satisfying the whole domestic market for oil could produce a net benefit to the balance of payments of about $90 million per year.

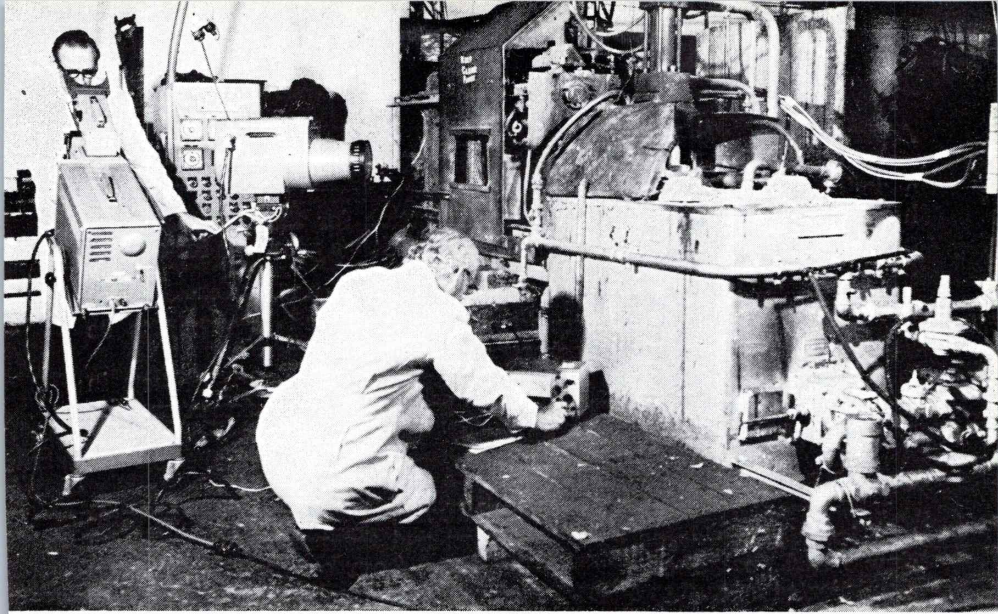
Radioisotopes in industry

In an industrial chemical process where the incoming reactants are being pre-heated by the outgoing product in a heat exchanger, any internal leakage is likely to give a contaminated product. Consequently, in such a process when quality falls for no obvious reason, the integrity of the heat exchanger may become suspect. In a highly integrated plant such as an oil refinery, it is not possible to shut down one section, to allow direct examination, without closing the whole plant. By use of a radioactive tracer gas, krypton-85, the possibility of a leak in one process line at a refinery was investigated. Any leakage was shown to be less than 1 percent. More recently the possibility of leakage in some heat exchangers in another process line was investigated and any leak was found to be less than 0.2 percent. In both cases the necessity of looking elsewhere for the trouble source was indicated and costly shut-downs were avoided.

Instrumentation of pressure die-casting machines

To keep closely in touch with the requirements of local zinc-alloy die-casters, a Zinc Die-Casting Technologists' Group in which Auckland Industrial Development Division is actively represented has been formed in Auckland. The main task of this group has been to disseminate the results of successful completed projects and to suggest new lines of investigation.

The Division's field of endeavour has centred on the application of instrumentation. To operate efficiently, die-casting machines should be fitted with instruments that record the injection speed of the molten zinc and the accompanying pressure changes in the operating cylinder, infor-



Surface temperature of a die is critical during casting of zinc-alloy metals. Scientists from Auckland Industrial Development Division monitor the temperature distribution in a production die-caster with a thermovision camera (centre-left).

mation which allows the machine operator to adjust the various controls until optimum operating conditions are obtained.

Recording equipment, installed on several zinc-alloy machines, has enabled immediate and significant improvements to be achieved in many plants. Better still, the potential value of the measurement technique and interpretation of the results have been shown to members of the Technologists' Group by displays and discussions at meetings, and demonstrations on production machines.

Metal-cutting expertise applied to cutting tobacco leaf

Metal cutting deals mainly with materials and tool geometries: speeds, feeds, and the different ways in which the work material moves or the tool moves in relation to the work, but the overall principles still apply, irrespective of the application. When a prominent cigarette manufacturer was losing production because of premature blunting of a rotary cutter blade in a tobacco-leaf slitting and cutting machine, Auckland Industrial Development Division's metal-cutting team was approached for advice.

Laboratory tests at AIDD revealed warping of the blade, insufficient hardness, and non-compliance with the tool geometry on drawing-office drawings. Recommendations were made on the use of hardened-steel blades, improvements to the basic design of the cutter, and some means of documenting the tool geometry more clearly.

A visit to the plant revealed other shortcomings – damage to the blade was being caused by the use of unsuitable setting screws, and the method of adjusting the clearance between blade and anvil left a lot to be desired in an equipment intended for continuous use. The recommendations made, when implemented, will increase productivity considerably and free staff hitherto engaged in rectifying faults as they occur.

Agricultural pilot's helmet

Christchurch Industrial Development Division recently completed a design project for a special helmet for topdressing pilots. The new helmet not only provides maximum protection for the head, but also allows for the installation of radio fittings and has a provision for a clean air supply for use when pesticides are being sprayed.

The helmet needed to allow good visibility and comfort when being worn in the high temperatures of the aircraft's cabin, but had to be light in weight and resistant to chemical fertilisers.

Laboratory tests have been completed, and prototype helmets in stringent field tests will ensure the new helmet fulfils its design promise so that commercial production can begin.

Optical design

The work of the optics section of Physics and Engineering Laboratory includes advice on optical systems and the manufacture of both simple and specialised devices; but even from an early stage quite sophisticated instruments were constructed for the laboratory, including an optical pyrometer and a fast spectrograph. During the International Geophysical Year special cameras for recording the whole visible sky were used, but those built overseas had a poor performance near the horizon. An improved "all-sky camera" was designed by the optics group and manufactured with the assistance of New Zealand industry. An international committee recommended its use for the International Quiet Sun Year, and about a dozen were sold to various countries. Many are still in use.

More significant commercially has been the development of a new navigation aid that marks a safe channel while also indicating to the mariner his deviation from that channel. The design was, with considerable assistance from the optics group, most successfully exploited by a New Zealand manufacturer and today there are 92 of these navigation lights operating throughout the world.

Lighting

In addition to maintaining photometric standards, a group at Physics and Engineering Laboratory has developed comprehensive facilities for testing street lighting lanterns and interior lighting luminaires and is able to supply lighting designers with the data they require. Besides testing production line lighting fittings for compliance with standards specifications, the laboratory has also been able to assist manufacturers with advice on new designs and by doing measurements on experimental and prototype luminaires.

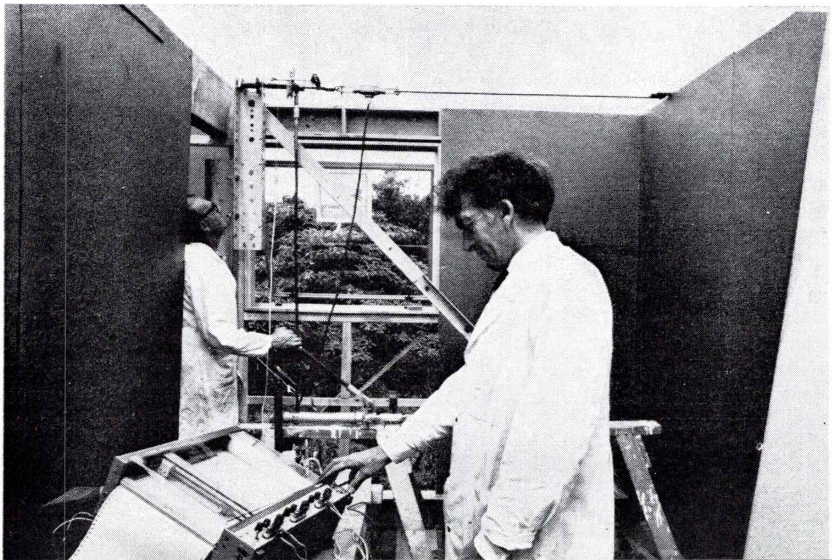
BUILDING AND CONSTRUCTION

Building structures

The traditional wooden house has given ample demonstration of its ability to withstand earthquakes, as also have massive concrete structures. However, in recent years new construction methods and materials such as prefabricated components, lift-slab floors, and prestressed concrete have been introduced into the building industry. When New Zealand embarked on the construction of many tall buildings about 15 years ago, design and construction to resist severe earthquakes presented engineers with many difficult problems. DSIR research on this subject aims to minimise earthquake casualties and damage, with the least possible increase in building costs. Studies are made of structural damage due to actual earthquakes, and DSIR staff have visited the sites of five overseas earthquakes during recent years. The knowledge and experience gained has been used to improve building codes and practices in New Zealand.

The damage caused by earthquakes is greatly increased if the building resonates. This will happen if the earthquake vibrations and the natural building vibrations have the same frequency. Working in co-operation with structural design engineers, DSIR scientists have carried out dynamic analyses of several major buildings in New Zealand. A vibrating machine is used to shake the building at a very small amplitude, and by using sensitive detectors calculations can be made to predict the behaviour of the building in a major earthquake. DSIR also operates seismological observatories, and a network of strong-motion accelerographs throughout New Zealand, installed both at ground level and in major buildings. By comparing building resonances with earth-

Prototype modular house being tested by AIDD for resistance to wind. The house is being pulled with a jack to determine its resistance to wind force. Load/displacement measurement, related to deflection of the building, is printed out on the recorder on the bench.



quake records the design features can be confirmed, and precautions taken against damage.

It has frequently been observed that the damage occurring during earthquakes varies greatly over short distances, and this variation is found to be controlled by the nature of the near-surface rocks and soils. Microzoning involves a study of local soils supporting buildings, so earthquake hazards can be assessed on a local scale. It is found that soil factors often have more influence on the hazard than do major regional features. Microzone reports have been issued on the Pauatahanui district, and on Wellington city. The area is divided into zones that differ in expected earthquake response, and hazards of earthquake-generated landslides are also assessed. Similar studies are being made of other population centres.

Analysis of damage following two recent earthquakes has confirmed the wisdom of decisions made in microzoning.

Building services

The use of services such as plumbing, heating, and forced ventilation is increasing in buildings; and at the same time the increasing cost of traditional materials is forcing designers towards the use of cheaper metals and of plastics for applications where well established materials such as copper have been used in the past. Over recent years several corrosion failures of stainless steel have been brought to the attention of DSIR, and it is obvious that many architects who have specified "stainless steel" for plumbing fittings are not aware of the wide range of alloys covered by this generic term, nor of the very special requirements of this material for design and fabrication if corrosion is to be avoided. Some buildings have experienced rapid failures of expensive fittings, sometimes even before the building was occupied. DSIR has been able to help with advice on the use of stainless steel, and also on plastic plumbing pipes and fittings.

Other DSIR research has been carried out on traditional copper and brass water fittings, which very occasionally suffer corrosion at an alarming rate. An investigation was made of the causes of "green water" during the first few years of service of new high-rise buildings in Auckland city, and a hexametaphosphate treatment was developed to avoid this trouble.

The energy crisis has caused an increasing interest in solar water heating, and DSIR has developed a new design that will combine cheapness with freedom from corrosion. The present situation has also made it important for New Zealand to conserve and supplement our traditional energy resources. Previous work has resulted in publication of a DSIR handbook for thermal insulation that helps designers to minimise heat loss from buildings.

Sound absorbing materials are widely employed for the reduction of noise in offices, workshops, etc. and also for reverberation control in concert halls and public places. Manufacturers and users of sound absorbants often need measurements of the performance of these materials. To improve the quality of this type of measurement, an intercomparison of test facilities is under way for sound absorption measurements between Australian and New Zealand acoustical laboratories.

Paint

About 75 percent of houses in New Zealand are sheathed with timber, and as exterior painting is the largest single item of maintenance involved in the protection of these national assets it can be seen that paint durability is of considerable economic importance. DSIR has conducted extensive outdoor expsure tests both on test fences and on experimental houses to determine the interactions of painting systems with various timbers under New Zealand weathering conditions. These investigations showed causes of failure and led to development of improved methods of painting weatherboards of preserved timber, knotty pine, and glued joints.

Generation and supply of electricity

The total value of electricity generating and distribution equipment in New Zealand is about $1500 million. DSIR co-operates with the New Zealand Electricity Department and the Ministry of Works and Development in a continuing programme of research needed to ensure that this equipment operates to the fullest efficiency.

When a major power development is undertaken, DSIR geologists assist with the site work, and give advice on foundations for dams, tunnels, canals, and power houses. During construction of the Tongariro Power Development, the Ministry of Works and Development has received engineering geological advice from the Geological Survey. Since 1967 engineering geologists have been investigating sites for engineering structures, recording geological data, and investigating special problems encountered during construction. With the completion of the western and central parts, the main emphasis is now centred on the final stages of the southern diversion for the Rangipo project. Cored drill holes, investigation drives and shafts, and geophysical data have been used to investigate rock conditions along the headrace and tailrace tunnels, and in particular for the underground power house. Detailed surveys of rock defects will be an important guide to the excavation methods and the final support installed for the power house. The geologists also help to find local sources of suitable construction materials – aggregate for concrete, rock and earth-fill for construction and for road making, and concrete additives such as pozzolans.

Other assistance is given by testing constructional materials before they are used, particularly sand, gravel, and cement for concrete. DSIR also comments on the condition of concrete during the life of the structure, and gives advice on specifications for cements, on the selection of aggregates and admixtures, and on the suitability, processing, and quality control of pozzolans. Special attention has been given recently to factors affecting heat generation in concrete, and current investigations include a comprehesive survey of the condition of concrete in a large number of dams throughout the country.

Hydro-electric generating plants have steel penstock linings and gate structures which operate immersed in freshwater under corrosive conditions. Access is often limited, so these surfaces need a durable paint. Another collaborative programme has enabled the most suitable types of paint to be selected. Cold damp conditions make application and drying difficult. Vinyl lacquers having good application characteristics and a 15-year service life have been developed, and are now made locally. In thermal power plants, fresh problems are arising, particularly on materials and methods of construction, on thermal pollution, and on metallic corrosion. DSIR scientists help with laboratory investigations and with advice.

Advice is also given over operation and management of the generating network, a matter that is becoming steadily more complex as the North and South Islands are linked, and as the network incorporates major thermal and geothermal stations into the traditional hydroelectric system. DSIR mathematicians have assisted Electricity Department engineers with computer models of the system, so the best operating combinations can be found in terms of economy, water storage, flood control, and environmental effects. Other assistance given has overcome problems of vibration of machinery, corrosion and metallurgical failures of power generation and distribution equipment, and protection against earthquake damage. Similar assistance is sometimes given to local authorities, and to manufacturers of electrical switchgear and reticulation equipment.

Three large thermal power stations (New Plymouth, Huntly, and Auckland No. 1) will generate 3000 MW of electricity, but will waste at least 5000 MW of heat. In addition, the Wairakei geothermal station rejects about 1500 MW to the air and to the Waikato River, and the Broadlands station will reject a similar amount. In Europe this type of waste heat from power stations is supplied as hot water to urban areas. The techniques, methods, and reticulation equipment are being studied, with a view to setting up a demonstration district heating scheme in New Zealand.

The large amounts of waste heat from thermal power stations are a potential threat to the ecological balance of New Zealand rivers and estuaries. Chemistry Division is testing a pilot-scale plant which uses this waste heat to evaporate sea-water to extract industrial chemicals.

Natural gas

In the development of Kapuni gas, DSIR mathematicians helped Mines Department to estimate the amount of gas available from the field, and this knowledge aided negotiations for use of the gas in electric power generation .Numerous problems arose in operation of the purification plant, and DSIR was able to assist in overcoming foaming difficulties, and to give advice on corrosion. Assistance was also given during construction and operation of the pipeline.

The lessons learnt at Kapuni have shown benefits in Maui development, and scientists were involved at an early stage to assist with specifications for purchase of the gas. DSIR is assisting with studies of alternative uses for Maui gas, to see if it would be more economical to use it for electricity generation and gas reticulation, or for petrochemical industries such as production of liquid motor fuels.

Water and sewage reticulation

Most assistance given to local authorities in this area relates to corrosion of metals and deterioration of concrete. A large amount of money is invested in pipes buried underground, and to help protect this investment DSIR has trial materials buried in 35 sites ranging from Kaitaia to Gore. These specimens include mild steel, concrete, cement-asbestos, and earthenware. The results of these tests are coupled with a programme of basic research on under-soil corrosion, and are made available to engineers designing pipelines. This knowledge is also used in investigations made for local authorities to discover the reasons for unexpected corrosion failures of equipment.

Recycling municipal wastes

Solid municipal wastes consist of organic and inorganic materials produced by domestic, commercial, industrial, and demolition activities. The organic fraction contains paper which could be recovered for recycling, with or without de-inking. It is common overseas to recycle up to 40 percent of paper. The remaining organic fraction could be used as fuel in electric power stations, or for the production of motor-vehicle fuel. The inorganic fraction contains materials such as iron and steel, non-ferrous metals, and glass, which could all be recovered for recycling. In co-operation with the Department of Trade and Industry,

Can this really be useful? DSIR is investigating ways of using or recycling at least some components of solid municipal waste.

DSIR is investigating the economics of recovery of these materials from New Zealand municipal wastes.

DSIR is providing technical assistance to the Auckland Regional Authority which plans to establish a centralised car shredding and refuse disposal plant. Scrap steel from the plant would be used in local steel works, and the scheme is expected to be operational by late 1977. This process is expected to recover scrap metals to an annual value of $\$\frac{1}{2}$ million, from materials that would otherwise be dumped.

TRANSPORT

Transport is a large industry responsible for about 10 percent of the gross national product, but the research effort devoted to it is not proportional to its importance in the economy.

The Government recently engaged a firm of consultants to conduct a survey of the New Zealand transport system (excluding urban passenger transport). Present and anticipated demand, the role and function of different methods of transport, and the extent and effect of competition between them were analysed, together with the economic and direct financial costs involved in the use of each method, and the most economical distribution of traffic. DSIR mathematicians, seconded for duty with the Ministry of Transport to help with the study, collaborated with the consultants in the development of mathematical models of the transport system, particularly rail and air networks. These models will aid in understanding the likely consequences of changes to the transport system, and will thus form a basis for the formulation of transport policy.

Good road marking is essential to guide traffic flows and reduce hazard. Chemistry Division tests road paints for durability and non-slip qualities on behalf of the Ministry of Transport. *Photo: Evening Post.*

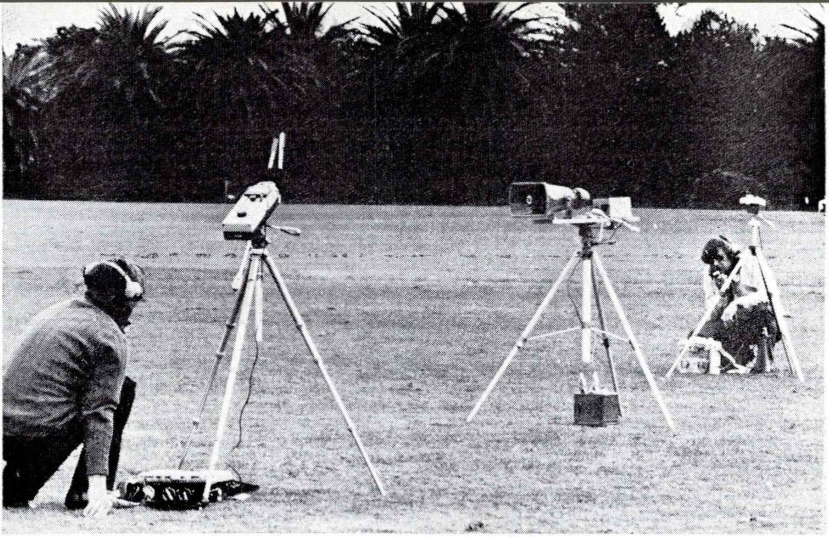
The greater part of DSIR research on transport investigates construction materials for bridges, fly-overs, rail cuttings, and tunnels, and the stability of the foundation materials on which these massive structures rest. Geological Survey and Soil Bureau provide the National Roads Board and New Zealand Railways with reports of investigations into the terrain and its underlying rocks for highways and railways, so the best and most economical route and form of construction can be adopted.

Bridges set particular problems in foundation engineering. The hazards of earthquakes set further problems in construction of transport works, and geologists map the existence of underground faults that might prohibit the use of sites that would otherwise be satisfactory. DSIR scientists and engineers have also concentrated on developing means of protecting the structure itself against damage by earthquakes, and the new reinforced-concrete viaduct being built as part of the planned Mangaweka deviation of the North Island main trunk railway line will incorporate special energy-absorbers designed by DSIR.

Other DSIR research is concerned with road safety. Poor visibility is an important factor in many accidents at night, and the Physics and Engineering Laboratory (with financial support from the National Roads Board) has set up a large distribution photometer to measure light distribution patterns. This work is being extended to assess the efficiency of vehicle headlamps, and the combined effects of street lighting, vehicle lighting, road surface, and glare on the driver's visual perception. DSIR scientists test car seat belts and motor-cyclists' helmets to ensure that these two compulsory aids to road safety give their wearers the protection that the law-makers intended. Other research is aimed at discovering the part played in road accidents by the use of both prescription and illegal drugs. Since very small quantities of some drugs may impair driving skills, it has been necessary to develop entirely new and very sensitive techniques of analysis for this work.

The use of paint to mark roads has continued to increase rapidly, and Chemistry Division has studied the performance of road-marking paints in road trials and has developed a specification for use by the Ministry of Works and Development when buying paint. Since 1959 manufacturers' samples have been regularly tested by applying transverse stripes to a densely trafficked road surface, and then observing how the paint samples wear over 6 months. Field trials are supplemented by laboratory performance tests of drying time, reflectiveness, and storage stability.

Noise is a growing problem in modern transport. DSIR measures the noise patterns around major airports, to ensure that developments will cause minimal noise pollution. Recent research has extended to measurement of traffic noise.



In noisy city streets effective sirens are essential for emergency vehicles. Here in the quiet of the Auckland Domain AIDD tests an ambulance siren (centre) for its sound level, frequency, and directional properties.

COMMUNICATIONS AND ATMOSPHERIC SCIENCES

The New Zealand ionosonde network

High frequency (HF) radio communication is worldwide and a complete knowledge of the ionosphere is essential to make radio services efficient and to minimise mutual interference. New Zealand, located in a sparsely populated area of the globe, has an obligation to provide data, from as much of this region as possible, for use by the international agencies which are responsible for dividing the radio frequency spectrum into bands and allocating specific channels for various services.

Ionospheric recording stations, run by the Physics and Engineering Laboratory's Geophysical Observatory at Rarotonga,and at Christchurch, Campbell Island, and Scott Base supply data to the international network for global services. The Ionospheric Prediction Service in Sydney also uses these data for regional prediction of radio propagation conditions. These predictions, for three months ahead, enable users of HF radio channels to select the most appropriate frequencies for the circuits in use, or alternatively to estimate when the allocated channels will be serviceable.

Continuous acquisition of ionospheric data is necessary to observe the interaction between the atmosphere and radiation from the sun. There is a considerable variation in certain components of the solar radiation, and disturbed conditions on the sun can disrupt HF radio communications. Many features of ionospheric storms are not yet well understood and the continuing study of this, and other upper atmosphere phenomena, will make HF radio communications more reliable and expand our knowledge of the properties of the atmosphere generally.

Geomagnetic disturbances

When energetic charged particles from an active sun reach the earth they can severely disrupt radio and telegraph communication. Geomagnetic storms are the magnetic fields of large current systems established in the ionosphere by the same solar particles and are thus very closely associated with communication disturbances. Many storms are preceded by characteristic signatures on a magnetic observatory record. Also, many storms tend to recur at 27-day intervals—the solar rotation period – even though they cannot be related to any visible solar feature. Both kinds of phenomenon are used for predicting magnetic disturbance. A network of observatories, of which Amberley is one, regularly sends the appropriate magnetic information to international agencies which issue forecasts to organisations concerned with communications. This work primarily concerns ground-based systems, but Amberley data were also recently requested when a malfunction of the Pacific communication satellite was being diagnosed.

It has long been known that telephone and telegraph systems using an earth return may also be put out of action during magnetic storms, as happened, for example, in Southland in August 1972. The agent here is the electric potential induced in the earth by the disturbance, a potential which sometimes amounts to hundreds of volts over long distances. More recently the same potentials have been observed to drive currents greater than 100 amperes through earthed lines in power distribution systems in the northern United States. Because of its size and latitude, New Zealand is less prone to this trouble, but it appears that such effects were observed in the Manapouri-Invercargill power lines, in the same 1972 storm, and damage to the installations is a real possibility in severe geomagnetic storms.

Geomagnetic observations

Navigation over long distances still relies to an extent on the magnetic compass, in spite of the modern development of sophisticated navigational systems. The disadvantage of the compass is the fact that its direction departs from true north by an amount that varies with place and time. For precise navigation these departures must be known, and the information is usually supplied in the form of a regional map having superimposed on it lines of equal magnetic variation and equal annual rates of change. Such maps are prepared from measurements made at magnetic observatories and on magnetic surveys.

The magnetic survey of New Zealand is conducted jointly by the Geophysical Survey of Geophysics Division and the Geophysical Observatory of the Physics and Engineering Laboratory. Observations are made every two years at a network of stations spread widely over the country, and at stations on adjacent islands as occasion offers. The sites are carefully chosen to be free as far as possible of any local magnetic effect, and so representative of the region. During the time these observations have beeen made, various magnetic changes have been occurring, and to refer all observations to a common point in time or epoch, corrections are derived for each observation from the recordings of the nearest permanent observatory. For the New Zealand area the Amberley Magnetic Observatory, operated by the Geophysical Observatory, is used. Such observations, supplemented perhaps by any relevant observations from ship and plane traverses over the same area at the time, are used to compile the magnetic charts for navigation.

The Amberley facility is also involved in the calibration of compasses in aircraft. Sites for compass swinging are checked for possible local magnetic disturbance – volcanic rock, buried pipes and steel reinforcing have all been found. The datum compasses which are used as standards in the calibration procedure are themselves tested against the absolute standard at Amberley at regular intervals.

STORAGE

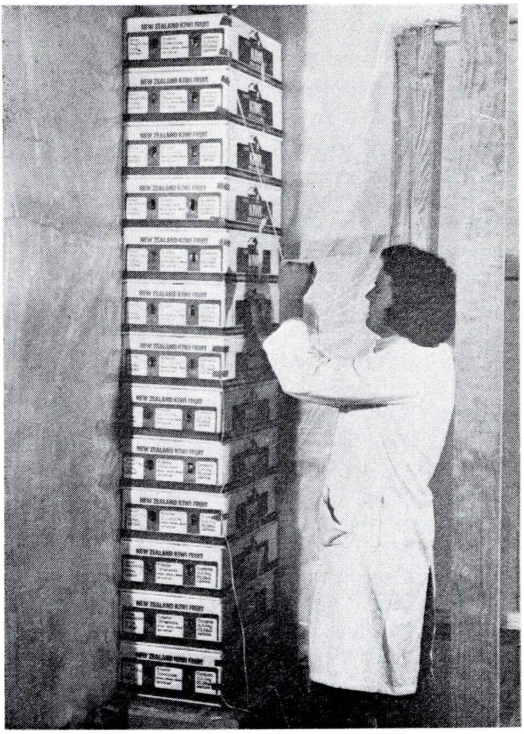
The success of our export economy dates from the development of refrigerated storage and its successful demonstration by the shipment of frozen meat to Europe in the *Dunedin* in 1882. The importance of storage in our economy has not been matched by a proportional local research effort. However, a small amount of DSIR research has been done, and an increasing expertise is being developed, in calculating and measuring the flow of heat and moisture in cold stores and on techniques of measuring the fluctuating temperatures of refrigerated produce during trans-shipment from works to rail waggon, and thence to ship. Not all storage is refrigerated, and other forms can give rise to problems, for example, fires in wool stores, or insect pests in stored cereal grains.

Fruit and vegetables

The traditional fruit crops exported from New Zealand have been apples and pears, which posed many problems in storage. Several varieties of apples otherwise regarded as good keepers are likely to develop a brown discoloration in the core zone if they are held in cool store after August, a condition known as coreflush. Research at Plant Diseases Division has shown that coreflush can be practically eliminated from the very susceptible variety 'Granny Smith' by periodic warming during storage; although apples treated in this way tend to become yellow, they remain crisp and juicy well into December. Another storage disorder of apples is superficial scald. Plant Diseases and Chemistry Divisions collaborated to apply an American discovery that scald could be prevented by the use of impregnated paper wraps.

An export trade is now developing in fruits such as Chinese gooseberries (kiwifruit). Research by DSIR on new export fruits established the conditions under which Chinese gooseberries could be stored for shipment to overseas markets.

In the home market, potatoes set one of the major vegetable storage problems. Inadequate control over temperature and moisture during storage can lead to a range of defects including cooking browning,



Experiments at AIDD on the airflow through cartons, and hence the cooling rate of fruit, are used to find the optimum carton design for efficient storage and container transport.

sprouting, undesirable texture, and disease development. Storage research is aimed at discovering the conditions of temperature, humidity, and air movement that will give, at the end of the storage period, the most siutable product for home use, factory frying, freezing, or dehydration. Seed potatoes set further storage problems. Research is also carried out on storage of other vegetables, such as kumaras and pumpkins.

Cereal grains

Wheat and maize are also seasonal products, which because they are in demand all year round may have to be stored for up to 12 months. These grains when stored must be kept dry and protected from damage from fungi, insects, and rodents. Scientists at the Wheat Research Institute have devised methods of measuring moisture levels in stored grain; and at one time a moisture testing service was provided during the harvest by field laboratories in the main wheat-growing areas. In this way, the industry was introduced to methods of measurement, and today all millers and merchants and many farmers have electrical meters for rapid measurement of moisture in stored grain.

With the recent dramatic increase in maize production, overseas techniques of silo storage have been introduced, and stores of 1000 tonnes capacity are now common. The technique of forced air ventilation has been introduced to local stores through DSIR experiments.

EARTH SCIENCES

Geological Mapping

Geological Survey publishes maps at various scales and showing geological information from the results of detailed fieldwork stretching back over more than 100 years.

One basic geological map series at a scale of 1:250 000 classifies rocks mainly by their age and covers the whole country. It is, however, limited by its small scale, and most new maps are being published at scales of 1:63 360 and 1:50 000. Where geological complexity warrants it the scale is 1:25 000. Maps of these large-scale series indicate the rock units in detail, as well as their ages, and are accompanied by short descriptive texts.

Other maps are produced for special requirements. Two have recently been published at 1:1 000 000, one showing the general geology of New Zealand as a reference or wall map and one showing only Quaternary geology (that of the last two million years). Some special-purpose maps show the position and details of recent movement along active faults; others show ground-water resources. Large-scale maps are used to show geological and mining details of coalfields and to show the geology of city areas.

Geological maps may be used for teaching and research by schools and universities; to assist the discovery and production of minerals by mining and oil companies; or for the siting and construction of buildings and engineering works by planners and engineers. Detailed geological information from the maps may be incorporated into land resource and capability surveys and used in studies of land stability or erosion.

Geophysical mapping

Systematic gravity and magnetic mapping of New Zealand complements the surface geological mapping by indicating the physical properties of the rocks within the Earth. In gravity mapping, the broad-scale work was done in the early 1950s, leading to the publication of the first small-scale gravity map of the country in 1958. Since 1960, Geophysics Division has concentrated on more detailed mapping at a scale of 1:250 000 (the same as the basic geological mapping), and at present 15 of the 27 map sheets have been published, 8 more are in active preparation, and more fieldwork is required for only 4 central South Island sheets.

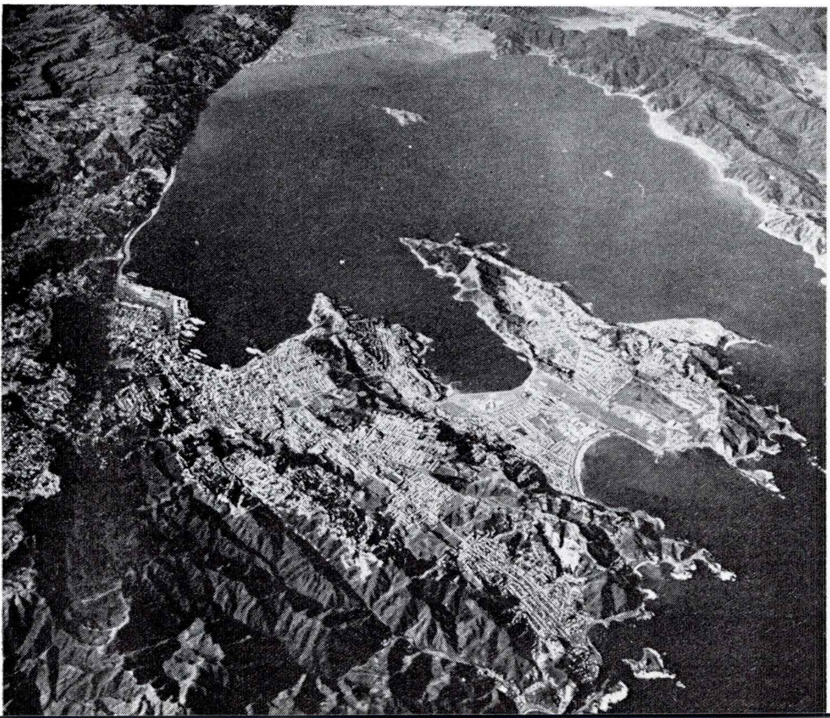
The first outlines of the magnetic field in New Zealand were determined at the turn of the century, but the first intensive mapping was an aerial magnetic survey of the Central Volcanic Region in 1949-52, and a ground survey of the Southland plains in the mid 1950s. After a long interval, aeromagnetic surveys were recommenced in 1968 with coverage of the northern part of the South Island, and have since been extended to the southern part of the South Island, and western North Island. Of the 27 sheets of the magnetic anomaly map at 1:250 000, 8 have been published and a further 9 are in press.

In addition to amplifying the data of surface geological surveys, and permitting quantitative estimates of the depths of structural features visible on the surface, the gravity and magnetic surveys have revealed the presence, deep within the Earth's crust, of large anomalous zones, the existence of which would never have been suspected on geological evidence alone. Notable amongst these are the large negative gravity anomaly stretching across the North Island from Cook Strait to East Cape, and the persistent linear magnetic anomaly which runs the length of the west coast of the North Island into Nelson, and reappears on the opposite side of the Alpine Fault in Southland.

Earthquake mechanism

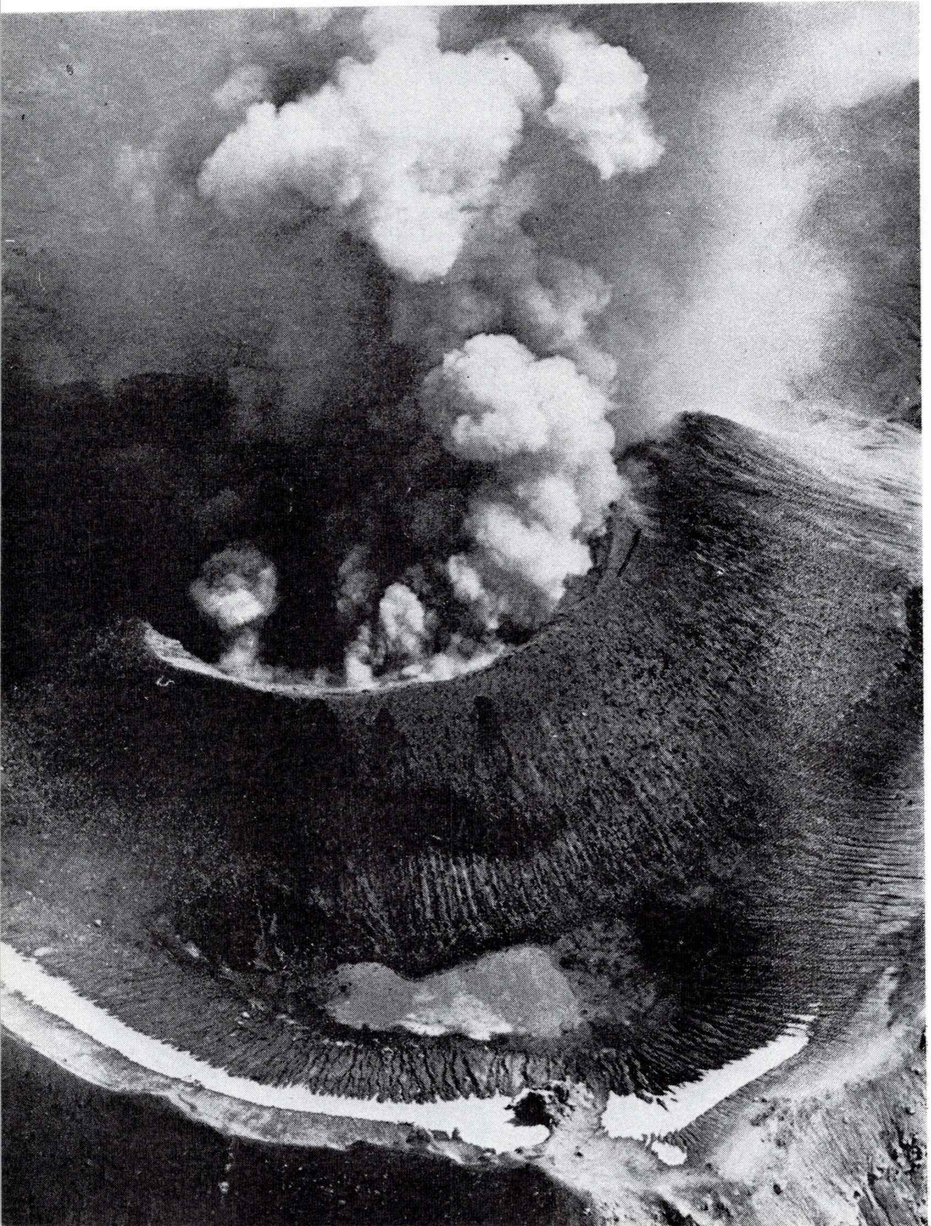
Recent work by New Zealand seismologists has greatly improved our understanding of the mechanism of earthquakes. We now realise that earthquakes have widely differing characteristics, and cannot be described adequately by a single measurement such as magnitude which gives a measure of the high-frequency energy radiated by an earthquake. The new concept of earthquake moment is needed to estimate the long-period energy. A simple method has been found for calculating moment from the seismograph records of large New Zealand earthquakes, and this can be combined with conventional determinations of magnitude, to give a complete picture of the physical processes occurring at the earthquake source.

The Wellington area is traversed by a number of major fault-lines, one of which is visible (left of the photograph) at the west of the harbour. DSIR geologists and physicists have prepared maps showing "microzones" in which damage from earthquakes can be expected to be more severe. *Photo: RNZAF.*



Studies have shown regional differences in the type of earthquakes in different parts of New Zealand. Besides having obvious scientific interest, these regional variations in the frequency content of earthquake waves are of interest to engineers, because high-frequency earthquakes will affect small, stiff, structures, while those with longer periods will have more effect on tall structures such as high-rise buildings.

Close-up of Ngauruhoe's summit during an eruption on 28 March 1974. The cinder cone, clearly seen here, was built by eruptions in June 1954. DSIR geophysicists regularly monitor the activity of the North Island's active volcanoes with a view to predicting future eruptions.



Ngauruhoe and Ruapehu

The active volcanoes of the Tongariro National Park have a history of fairly continuous activity of one sort or another culminating, at intervals of some years or decades, in eruptions which are a serious threat to anyone in the vicinity. With the increasing popularity of skiing on the slopes of Ruapehu, much greater numbers of people are at risk. Systematic observation of visible volcanic events has been going on for several decades and while observations of physical phenomena are of growing importance in defining the activity of Ruapehu and Ngauruhoe, their study has not yet yielded any unequivocal method of predicting an eruption of Ruapehu of the type which has occurred twice in the last six years.

Explosive eruptions occurred at Ngauruhoe on 19 February 1975 and at Ruapehu on 24 April 1975, and although shortlived they were the most violent outbursts since lava was erupted in 1954 from Ngauruhoe and in 1945 from Ruapehu.

The Ngauruhoe events commenced with the continuous emission of ash, and ejection of incandescent rocks which avalanched down the cone. The ash clouds rose to about 13 000 m above sea level, and winds carried ash beyond Hamilton, Rotorua, and Tauranga. Later came a series of violent explosions which ejected blocks weighing up to 3000 tonnes in the crater area, and hurled smaller rocks up to 3 km from the vent. Geologists observed events closely, and from photographic and geological records have been able to quantify the eruptive mechanisms for the first time. The eruptions were spectacular, but fortunately not damaging.

By contrast, Ruapehu erupted unseen, but it destroyed structures and put life at risk. More than 1.6 million m^3 of Crater Lake water were ejected, rocks fell up to 1.5 km from the crater, and ash was blown downwind beyond Hastings. Lahars with peak flows up to $5000 m^3/sec$ poured down mountain river courses to destroy small bridges and ski installations and fill the Tongariro Power Development tunnel at Mangaio with water and debris. Falling debris damaged a Park Board hut and DSIR instrument pit near the summit. Geological investigations have shown that the eruptive mechanism was probably a high-temperature steam-blast followed by base surge, with no new lava involved.

The Tongariro National Park Board is concerned to provide at least a few minutes warning of an eruption so that skiers on the mountain can get to higher ground on the ridges and out of the path of the water. Advice to the Park Board has been given on two aspects. Firstly, the probable paths taken by a lahar originating in Crater Lake have been mapped. Secondly, it has been observed that an eruption at Ruapehu is often preceded, by less than a minute, by an earthquake originating near the crater. Even if the mountain is obscured by cloud, a seismometer placed high on the slopes would detect the earthquake, while a distant seismometer (10 km away) would, by the absence of any comparable shock, confirm that the earthquake was local to the volcano and not a large, distant earthquake. Systematic observations have thus suggested the basis for a method of giving those on the slopes of Ruapehu at least a few minutes warning of a possible eruption, and a chance to reach safer ground.

Earth deformation studies

Many large earthquakes in the past have been accompanied by spectacular movement of the surface of the Earth along well-defined faults. The displacement that occurs during an earthquake is the most obvious movement but is really only the release of elastic strain that has accumulated slowly over many years. During the years between, a steady movement occurs in the blocks surrounding the fault, until a point is reached when the elastic strain is sufficiently great to cause a fracture at the fault. At this point the sides of the fracture (or fault) spring back towards an unstrained position, and the elastic energy is released in the form of an earthquake. The slow movements that occur between earthquakes in the vicinity of faults are probably as important to our understanding of such earthquakes as the movements that occur during earthquakes.

To assess the nature and rates of present-day deformation, knowledge of past deformation is essential, as the evolution of deformation demonstrates a gradually changing nature, location, and rate. Five broad zones of different tectonic regimes can be recognised in New Zealand, with contrasting rates of horizontal and vertical deformation. One of these extends through eastern North Island and northeastern South Island; this is the shear belt and is a particularly active area, for which a periodicity of deformation has been derived.

Active areas are being mapped on a scale of 1:50 000 or larger. These maps show fault traces, measured displacements, and deformed surfaces of different ages, dated by relative and absolute dating methods. Such tectonic maps also assist local bodies in preparing their district planning schemes.

Another method of studying strain accumulation is to compare old triangulation survey data with those from modern resurveys. As old triangulation surveys are not too accurate, special mathematical techniques have had to be developed to extract systematic changes from random observational errors. These newly developed techniques have recently been applied with considerable success to surveys across the four major faults in the Marlborough District. Comparison of triangulation surveys made in 1878 to 1884 with the resurvey of 1951 to 1960 has shown that shear strain is increasing at a mean rate of 0.5 ± 0.1 microradians per year across a zone about 100 km wide. It has been possible to show that no slip has occurred on any one of the Wairau, Awatere, or Clarence faults during the interval between the surveys. On the Hog Swamp Fault, a small fault south of Seddon, however, the concentration of shear strain is consistent with a displacement of about 300 mm on the fault. The total annual movement across the Marlborough shear zone has been estimated to be between 25 mm and 45 mm. Not all this movement is necessarily released on one of the four major faults; the average annual movement on the faults from geological evidence is only about 14 mm.

Modern surveys of deformation, using precision instruments, are extremely accurate. Thirty small patterns (4 × 6 km) across active faults are being monitored at 3-yearly intervals. To detect strain accumulation outside the narrow zones, fault "nets" (40 × 60 km) allowing for the curvature of the earth are observed at 2–4-yearly intervals. An azimuth-distance scheme specifically designed to rapidly detect deformation over a large area is now being installed and will be observed at 3-yearly intervals. Some anomalous deformation has already been recognised as a possible precursor to earthquakes.

Hawke's Bay Pliocene limestone

The potential of the thick, porous, Pliocene limestone, known generally as Te Aute Limestone, which forms prominent hills on the East Coast from northern Wairarapa to Gisborne as an oil reservoir has attracted considerable interest from oil companies. The Geological Survey has undertaken closer study of its fossil content and field relationships to gain a bettter understanding of the conditions under which it accumulated and to predict where suitable geological structures occur which might trap oil.

Large fossil scallops of the *Phialopecten triphooki* group have been of great value in enabling the limestone to be separated into different ages of accumulation in different areas. Collections made from about 200 localities have helped to demonstrate that the limestone is not one sheet, as formerly thought, but formed along both margins of a narrow seaway that slowly filled with sediment during Pliocene and Pleistocene time.

Analytical services

Chemical studies of natural materials have provided essential support for some projects of major economic importance to New Zealand, such as analyses of ironsands for the steel industry, and the evaluation of the Coalgate bentonite and its conversion to a desirable swelling form by ion exchange. Analytical services have continued to support a variety of mineral development projects such as: prospectors' samples for precious metals; drill-cores from the Tui Mine, Te Aroha, and from Macraes Flat, Central Otago; antimony-bearing rocks from Endeavour Inlet, Marlborough Sounds; halloysite filler clay from North Auckland; phosphate rocks; magnetite-rich rocks from Fiordland; and ilmenite-rich sands from west coast beaches.

OCEANOGRAPHY

Continental shelf

Increased interest in offshore mineral and oil exploration has led to increased studies on the continental shelf around New Zealand. The New Zealand Oceanographic Institute's 1:200 000 and 1:1 000 000 bathymetric and sediment charts have provided the basis for broad surveys of shelf structure and investigations of shelf mineral resources.

A 1:6 000 000 chart based on a compilation of this information has been invaluable for delineating licensing areas for offshore prospecting and, more recently, for application of the proposed continental shelf formula for territorial waters.

A number of recent developments on the shelf have given impetus to extended studies. The development of the Maui field has involved Oceanographic Institute in surveys of possible pipeline routes using side-scan sonar techniques. The possibility of overseas phosphate becoming increasingly expensive has made the discovery of glauconite and phosphorite on the Chatham Rise look attracive as a long-term alternative supply, demanding more detailed assessment of the deposits with a view to eventual mining. The export value of ironsand has prompted a closer look at the potential of offshore deposits.

Research on the shelf morphology and sediments in selected areas is being given more detailed attention. Using side-scan sonar, it is possible to carry out fine-scale mapping of floor sediments, and the structure of unconsolidated sediment layers can be investigated using coring equipment and sub-bottom profilers. Knowledge of sediment behaviour is especially important in the siting and bedding-in of offshore oil drilling and production platforms. As offshore operations become more extensive and move into deeper water, better knowledge of the subsea sediments and rock structure will be needed when engineering requirements are being determined. Sediment behaviour studies, using remote sensing instrumentation, have become increasingly important in assessing environmental problems and are being used to examine silting in harbours and the dispersal of industrial and domestic effluents in the sea.

Tsunami studies

"Tsunami" or tidal waves can be extremely destructive. If they originate locally, e.g., at the time of an earthquake, the absence of warning gives little time to take protective measures; but if they originate some thousands of kilometres away the interval before their arrival gives time for precautionary measures. An international warning system, based in Hawaii, gives some assurance of advice of the possible arrival of a tsunami on our shores.

From knowledge of the bathymetry in the Pacific Ocean, the travel times of tsunami have been calculated and reproduced as lines of equal phase on a Pacific scale chart. When the time and point of origin are known, or a tsunami has been observed at intermediate points on its travel path to New Zealand, the chart can be used to predict arrival times with reasonable accuracy.

The way in which many New Zealand harbours will respond to excitation by long waves has been determined from the recorded responses to the major 1960 Chilean and 1964 Alaskan tsunami.

Foreknowledge of the arrival time and of the areas most likely to respond dangerously has helped create an effective tsunami warning system for New Zealand.

Lake surveys

Increasing awareness of the importance of lakes as a water resource and as a precious element of the environment has developed over the last decade. The Oceanographic Institute has become involved in lake studies through the application of oceanographic techniques and equipment to the study of 60 New Zealand lakes. Thermal changes are being

The increasing demands placed on inland waterways for hydroelectric generation and recreation, and the ever-increasing threat of pollution means that more information on New Zealand lakes is needed. Here, scientists from Oceanographic Institute are using an echo-sounder to produce a chart of the bathymetry of Lake Tekapo.
Photo: W. Main

monitored in selected lakes to provide definitive and baseline data for biological studies, and coincident underwater photography on the lake bottom and collection of sediments provides information on animal populations and habitat, adding to our knowledge of food available for fish populations.

The information collected is used in studies of fishery resources, water utilisation, lake weed problems, hydro-electric power schemes, water catchment needs, and eutrophication effects.

Ocean temperature surveys

At the inception of the New Zealand Oceanographic Institute in 1954 the only knowledge of the distribution of hydrological properties in the oceans around New Zealand was contained in isolated observations by foreign oceanographic expeditions. Research into ocean water properties in the 1950s was often determined by the availability of ships. When ships were regularly chartered in the 1960s, and later when a research vessel was acquired, a programme of hydrological surveys up to 500 km offshore around New Zealand could be commenced. The surveys, which were all conducted in February and March each year so that the data would be comparable, were completed in 1973. These data not only define the temperature, salinity, and density field around New Zealand to a depth of 2500 m in some detail, but also allow the mean circulation to be evaluated by indirect methods.

Areas of special interest highlighted by the broad scale surveys have subsequently been studied in more detail allowing the seasonal and non-seasonal changes to be evaluated. The complete set of data provides an essential base for correlation studies in all other marine disciplines. For example, co-operative studies with fisheries scientists have proved profitable in establishing correlation between sea surface temperature and the occurrence of tuna.

BIOLOGY

Survey and management of reserves

When planning nature conservation, it is essential first to know what is present in existing reserves. Since 1971 Botany Division staff have been assessing the botanical content of each reserve. This and any other relevant information is recorded in a standard form and made available to the Department of Lands and Survey. The first result of the work has been the publication of "The Scenic Reserves of Canterbury", by G. C. Kelly (1972), which assembles information on the 60 reserves in this district and which formed the basis of an attractive booklet with the same title, prepared by L. W. MacCaskill. Field work for the Nelson land district is now complete, and has been a very useful background against which to assess the biological reserves proposed under the beech utilisation scheme. Work will soon begin on a survey of Wellington reserves, and other members of Botany Division are extending the project to Auckland, Otago, Southland, and Westland.

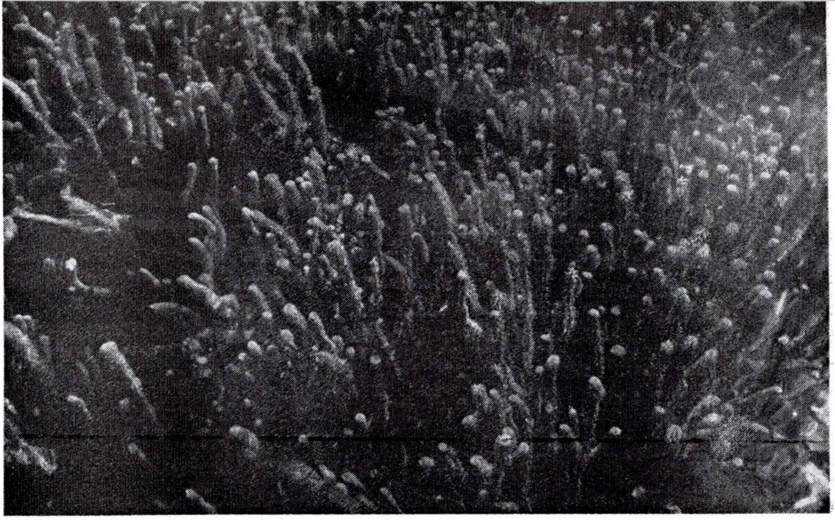
Over the last 10 years, Ecology Division has also investigated many problems in fauna and flora reserves, and has influenced the philosophy of reserve management by inculcating a more scientific approach. Studies of outlying islands, National Parks, and native forests have shown that reserves usually require active management rather than passive protection, and that management must be based on research and sound ecological knowledge. Otherwise avoidable mistakes will be made.

It is even sometimes best not to disturb "noxious" mammals on reserves for native fauna and flora. In 1963 rabbits were removed from Motunau Island because they seemed undesirable there, though no attempt had been made to assess the supposed damage they were doing either to the tussock vegetation or to the nesting seabirds for which the island was reserved. In the event, their removal triggered off unexpected changes including the invasion of the island by boxthorn and the smothering of native tussocks by introduced grasses. As a reserve for nesting seabirds and as an example of silver tussock grassland, Motunau was better off with rabbits.

Nutrients limiting plant growth in freshwater

A Freshwater Section of Ecology Division was set up in 1970 to carry out research on lakes and rivers, and in particular on eutrophication, and is now located at Taupo, where its major projects are based.

Recent work by the section discovered that phosphorus, the nutrient limiting aquatic plant growth in most freshwaters, occurs in considerable quantities in rivers of the Central Volcanic Plateau of the North Island, but that inorganic nitrogen is in short supply. This means that the control of eutrophication in central plateau lakes by limiting the input of phosphorus will probably be less successful than in most other parts of the world. The Government has recognised this by recommending that restoration of Lake Rotorua should involve the diversion of all treated sewage effluent out of the catchment, rather than mere removal of phosphorus from it. Bioassay studies support this decision, for sufficient phosphorus has always been found in Lake Rotorua to allow



Ecology Division's Freshwater Section has surveyed New Zealand's lakes for aquatic weeds, such as *Lagarosiphon major* (above), which are of increasing concern in hydro-electric and recreational lakes.
Photo: N.Z. Electricity Deprtment.

algal growth, while nitrogen has been scarce enough to limit plant production.

The proposal to divert treated sewage effluent from Rotorua city to the Kaituna river has caused public concern. Ecology Division has examined the nutrient status and algal content of the river and has concluded that, because the water passes rapidly downstream, most of the added nutrients will reach the sea without being incorporated into plant material.

Quaternary botany

The post-glacial forest pattern was formerly considered a simple one with the transition from podocarp to beech forest being the result of a deteriorating climate. Work by Botany Division in the central and southern South Island showed, however, that the pattern was complex. Studies in both islands showed that elements of podocarp forest, e.g., rimu, spread at different times, e.g., in Otago and Westland, and in both islands. These results, combined with information on the role of minor forest species, have provided an understanding of the role of climate on post-glacial vegetation in New Zealand.

Floras

A "Flora" is a taxonomic account, usually somewhat formalised, of the plants occurring in a country. New Zealand has had a unique history of "Floras", J. D. Hooker's, available not long after settlement, being followed by others up to 1925. Two volumes of the newest series produced by Botany Division have been published (1961 and 1970) and treat the native species, but the total flora includes very many naturalised species that have arrived here from Europe, America, and Australia. These species, numbering at least as many as the native ones, are now the subject of further volumes in the "Flora" series. One well advanced volume deals with introduced sedges and rushes of pastures together with the brightly coloured lilies, irises, and their relatives – all garden escapees. Others, describing the grasses and dicotyledonous weeds, are in preparation.

European wasps

European wasps, which were accidentally introduced to New Zealand about thirty years ago, are widely established, creating a nuisance and potential hazard in both towns and the countryside. To provide control in broken country in and around forests and resort areas, Entomology Division has developed an attractant bait of reconstituted freeze-dried fishmeal containing the insecticide "Mirex", one of the few toxic chemicals not repellent to wasps. During the summer, foraging wasps actively seeking protein for larval food carry the bait back to the nest where it kills off the brood when it is fed to them. This protein insecticide bait is now commercially available and is being tested as a method of abating the wasp nuisance during forestry logging operations. Protein baits must be used in the summer period, in advance of the build-up in wasp numbers, as later in the year foraging wasps seek carbohydrate food sources.

Disease records

Disease of plants may be caused by parasitic fungi, bacteria, viruses (including mycoplasmas), nematodes, or by a physiological condition. An important part of any country's plant pathology service is to list accurately the diseases known to occur there. This has been done regularly for New Zealand by Plant Diseases Division. A first list, published in 1939, contained 411 diseases. The list most recently published (1969) contains 894 diseases – 726 fungal diseases, 28 caused by bacteria, 69 virus diseases, 19 nematode infestations and 52 physiological disorders. A new list now being prepared will probably contain records of a further 200 diseases.

Facial eczema

From 1955, biologists at Soil Bureau were studying the ecology of soil organisms, particularly those under tussock grassland, native forests, and adjacent introduced pastures. Some organisms are strongly influenced by the kind of vegetation and also by season, and collaborative research with the (then) Department of Agriculture culminated in the demonstration that a pasture fungus, *Pithomyces chartarum,* was the cause of facial eczema, which is strongly seasonal. Subsequent facial eczema research by other Divisions and by the Department of Agriculture has led to management methods that have substantially controlled the disease.

ANTARCTICA

Regional mapping

A folio of Antarctic geologic maps on a scale of 1:1 000 000 was published in 1969 by the American Geographical Society. New Zealand geologists contributed four of the eighteen map sheets and accompanying texts, covering most of the Trans-antarctic Mountains between the Horlick Mountains and the north Victoria Land coast. Since then, geologic mapping activities have been directed towards the resolution of major stratigraphic/structural problems,

Scientists removing core samples from the drilling rod at the New Harbour Dry Valley Drilling Project (DVDP) site, Antarctica. Information from the drill-cores has consolidated evidence for the existence of Gondwanaland and the subsequent continental drift. *Photo: F. P. Szydlik.*

International co-operation

Arising out of the regional mapping programme, a lexicon of stratigraphic names was compiled and distributed in 1975 as part of a Scientific Committee on Antarctic Research project. Geologic and tectonic maps are also being compiled both for SCAR and for the Circum-Pacific Map Project. An International Geological Correlation Programme proposal to correlate rock strata and tectonic and metallogenetic belts in East Antarctica, East Australia, and New Zealand, areas once contiguous on continental drift reconstructions, has been approved by the International Union of Geological Sciences.

A working group of New Zealand and Australian geologists started joint investigations in 1974-75 of north Victoria Land and New Zealand and will continue in 1976 in Tasmania and Victoria to study the problems raised when the Southwest Pacific continental land masses are considered as fragments of the ancient land mass, Gondwanaland.

Dry valley drilling project

In the 1975-76 Antarctic season the four-year-long international Dry Valley Drilling Project (DVDP) ended. From the start, the project was very successful, with outstanding co-operation shown between scientists from New Zealand, the United States, and Japan. New Zealand scientists have played a major part in the study and interpretation of core samples from the various drill-holes.

New Zealand's other responsibility in the project has been to provide a team of drillers each season. These men operated the rig continuously during the periods of drilling, often under very harsh conditions of wind and cold.

Results from DVDP are consolidating the evidence for the existence of the continent Gondwanaland and the subsequent continental drift which has formed the Earth's surface as we know it today.

Antarctic soils

Widespread examination of Antarctic soils by Soil Bureau has resulted in the recognition of frigic soils as the normal soils of Antarctica. Characteristically they have negligible organic matter, a very low rate of chemical weathering and a relatively high rate of physical weathering. They have features of soils of arid climates including the accumulation of water-soluble salts such as sulphates and nitrates of sodium, magnesium, and calcium, together with traces of iodate. The salts occur in the most arid parts of Antarctica as a discrete horizon up to 10 cm thick, a little below the surface of the soil. The thickness of the salt horizon increases with the age of the soil.

It is believed that compounds of nitrogen, sulphur, and iodine are transported to the polar regions by the atmosphere, oxidised, precipitated with snow, and transported by wind from the polar plateau to areas of bare ground, where they accumulate when the snow evaporates. Chloride is present in snow at the polar plateau, but is absent in the salt horizons in the soils and may be removed preferentially. The similar ratio of nitrate to iodate between the Chilean nitrate deposits and those in Antarctica suggests that the mode of origin in each area may be similar.

HUMAN HEALTH

Although the primary responsibility for research into human health lies with the Medical Research Council and the Department of Health, there are many functions in public health, and in research into human health, that DSIR can fulfil more effectively than other organisations, and DSIR has always maintained a large scientific effort in this field. When the Department of Health requires the support of scientific testing and research facilities additional to its own resources (in its National Health Institute and its National Radiation Laboratory) for foods, pharmaceutical drugs, air, water, industrial practices, and environmental pollution, this support is provided by DSIR. The total research activity by DSIR in human health amounts to almost a million dollars annually, concentrated mainly into research on medical instrumentation and diagnostic equipment, support for public health services (including nutrition and pesticide research), and basic medical research.

Medical instrumentation

In collaboration with doctors engaged in research in New Zealand hospitals and universities, DSIR has developed special instruments and techniques, many of which have reecived acclaim from overseas authorities, and some have resulted in a thriving export business.

Many patients in critical care units must spend long periods under totally artificial respiration on respirators which provide dry, cool air mixtures. If the nose and upper airways are by-passed, as is often done, the supply of dry, cold air direct to the lungs can cause problems, so DSIR has developed a humidifier that delivers air to the lungs at body temperature and with a relative humidity in excess of 85 percent, at all breathing volumes. The Critical Care Department in Auckland is equipped with the humidifier, and the management of patients has been greatly improved by its use. The equipment, which is patented throughout the world, has been developed in close collaboration with a commercial manufacturer, who is using a well established, overseas marketing organisation to exploit its export potential.

In intensive care departments, the heart action of patients recovering from coronary failure is monitored, but the restraint of being wired to an instrument is obviously unsatisfactory. A small radio transmitter has been designed to be worn by the patients and send electrocardiograms and other information on heart action to a central recording and monitoring station. The installation in the intensive care ward at Green Lane Hospital, Auckland, is operating satisfactorily, and the equipment is finding applications in sports medicine, in research on animal physiology, and in industry. Exports to Australia are being developed.

DSIR has worked closely with the obstetrics department at National Women's Hospital to develop a device to monitor the foetal heart rate in pregnancy, particularly just before and during delivery. The experimental model has now been well tried in use, and it is hoped that the need for a number of units to fully equip National Womens' Hospital can be met by local production.

A technique widely used in clinical testing for thyroid disorders is measurement of the Achilles tendon reflex time. The usual technique is to have the patient kneel on a chair. The Achilles tendon in the heel is then tapped with a rubber hammer, and the resulting reflex movement of the foot is assessed by the doctor. An instrument has been developed by DSIR to measure the tendon reflex time automatically and with a high degree of accuracy, making the doctor's task easier, and the test more precise.

Medical supplies that were once heat sterilised are now frequently sterilised by exposure to a source of gamma radiation. In 1962, technical discussions between DSIR and industry led to the installation of a local, commercial, gamma-sterilisation plant, which started operating in 1965. Production from the plant has removed the necessity to import high-cost disposable articles from overseas, and has encouraged local manufacturing of such items as surgeons' disposable gloves. Exports of goods sterilised in the plant have been considerable, and it is estimated that in terms of imports, the savings to New Zealand have been about $5 million over ten years of operation. DSIR established and monitored the dosimetry system operated in the plant.

Public health

The Department of Health operates a large programme of preventive medicine, largely through the offices of the local Medical Officers of Health, and DSIR supports this programme with laboratory services. Inspectors from the Department of Health take samples of a wide range of foods, waters, pharmaceutical drugs, children's toys, and other materials used by the public, to be examined by DSIR scientists for chemical and bacteriological quality, and analysed for the possible presence of poisonous substances. DSIR scientists assisted Department of Health officers in drafting the present Food and Drug Regulations, defining standards of quality and purity.

Chemistry Division tests the paints used on children's toys to ensure that they do not contain lead and similar toxic metals.

The many analyses made of public water supplies have been compiled into four water "atlases" which give the typical chemical constituents of the main water supplies throughout the country. The results of the analyses of 308 public supplies serving a population of over 2 million, when compared with World Health Organisation criteria, showed that New Zealand's drinking water is generally of very good quality.

Foods on sale to the public are analysed to determine their purity and nutritional value, and the presence of additives used as preservatives, antioxidants, colouring materials, conditioners, flavouring substances, and sweeteners. Causes of contamination which have been found include accidental addition of foul objects, chemical contamination suffered in storage or transport, and vague taints and odours that are sometimes accidentally acquired. Investigations also monitor the occurrence in natural foods of residues of pesticides and industrial chemicals, and the introduction of toxic metals from cooking utensils and cans into foods. Industry is assisted to improve production and processing techniques to prevent contamination as, for example, when canning methods were altered after discovery of high lead levels in some canned foodstuffs. New pesticides are tested before they are introduced to determine if they form toxic residues, and regular checks are made both of food on sale to the public and of the environment, to ensure that no pesticide problems exist.

The Health Department is concerned to ensure that prescription drugs and other medicines on sale to the public are of the required purity, strength, and composition. DSIR assists by analyses. In a continuing programme, groups of related drugs are analysed and compared, and complaints about the ineffectiveness of drugs are investigated. This work assists the patient by detecting inefficient or erratically performing drugs (which can then be withdrawn from the market), and prevents public expenditure on substandard products.

Other contributions to public health include the measurement of noise levels, testing of protective devices such as ear-muffs, and collaboration with other agencies in formulating New Zealand standards and noise ordinances.

Basic medical research

DSIR carries out a small amount of basic medical research, working in close collaboration with medical research groups, usually in universities. Research has been done on trace elements in body tissues, tooth decay, blood flow in the placenta, rates of replacement of body tissues, myelin sheath structure, and cell junction organisation. In addition, assistance has been provided to medical research groups, through electron microscopy studies of arthritis and of pathological states of intestinal epithelium.

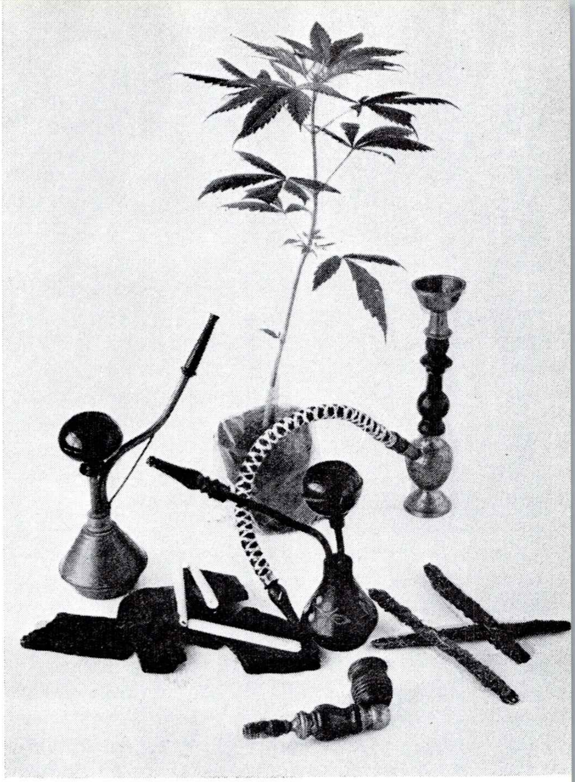
OTHER SCIENTIFIC SERVICES

DSIR provides scientific support services to law enforcement agencies, such as the Police Department, Department of Justice, and Ministry of Transport. Items of evidence are referred to DSIR for examination and analysis in cases where it is suspected that a crime has been committed, as also are specimens from coroners' inquests. The increasing load on the forensic laboratories cannot be met solely by staff increases, but is being met by using increasingly complex scientific techniques in the investigations. Forensic scientists sometimes accompany police officers to the scene of the crime, and help them gather evidence, which is evaluated in DSIR laboratories, where it can be studied and interpreted in a scientific and dispassionate manner. DSIR scientists are often required to present evidence in Court, and be available for cross-examination. In addition, DSIR scientists lecture at police training courses to familiarise police officers with the latest developments in forensic science, and with techniques of collecting scientific evidence.

When a person dies from an unknown (or uncertain) cause, the coroner will probably request a pathologist to carry out an autopsy, and when necessary DSIR carries out analyses for poisons. In rare cases a criminal aspect may be revealed.

Crimes against the person and crimes against property usually involve some form of contact, and in such cases there will be a transfer of substance, no matter how microscopic. DSIR scientists assist the police by matching fibres, body fluids, fragments of paint or glass, dirt, explosives, etc., thus assisting in the establishment of guilt. These techniques are also valuable in hit-and-run vehicle offences. Firearms also are identified, together with bullets and cartridge cases. Sophisticated techniques of identification are applied to blood and dried bloodstains.

Fire in an aircraft cargo hold at Christchurch Airport, 1975. DSIR investigations attributed responsibility to a chemical being carried (contrary to regulations) in a passenger's suitcase. *Photo: A. James*

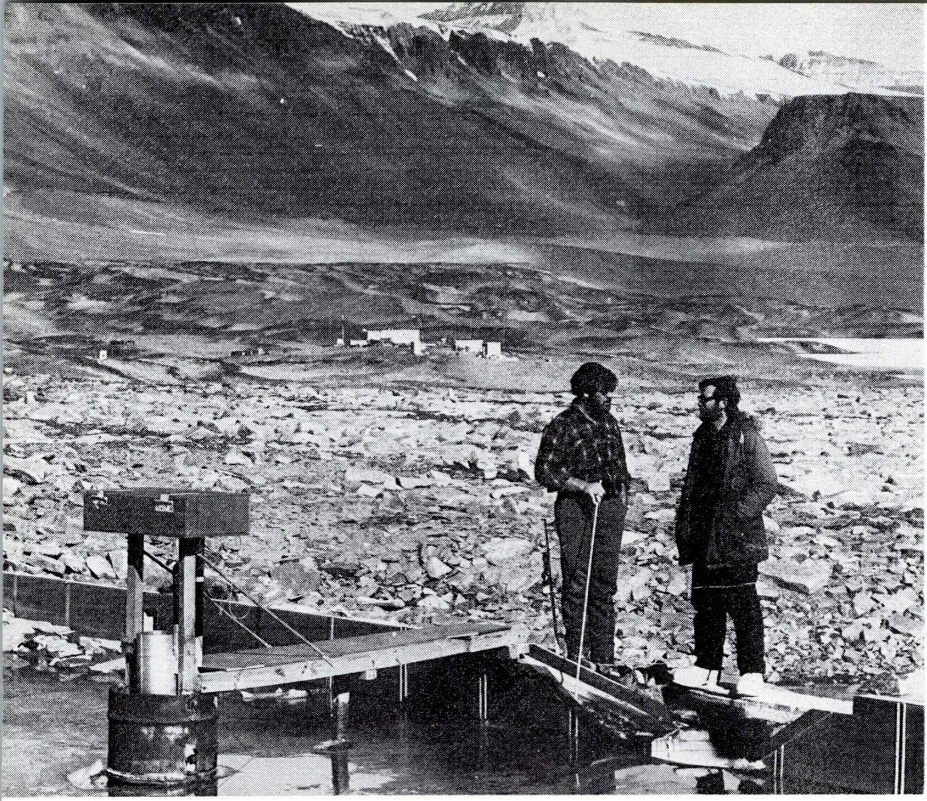


As part of its forensic responsibilities DSIR identifies seized drugs. A cannabis plant, hashish, "joints", and cannabis sticks are shown.

Illegal drugs seized by the police are identified, as also are traces of drugs found in the possession of suspects who may have hidden or otherwise disposed of the bulk of their holdings. Over the last five years there has been an eight-fold increase in the number of illicit drug seizures in New Zealand, and more than 1000 cases are now examined annually by DSIR scientists. The majority of these involve cannabis (in its various forms), but LSD, opium narcotics, and prescription drugs are frequently detected.

Since May 1969 it has been an offence for the driver of a motor vehicle to have more than 100 milligrams of alcohol per 100 millilitres of blood. Blood samples taken under Ministry of Transport supervision from suspected drivers are sent to DSIR for analysis; during 1974, some 11 000 samples were examined. The methods of analysis are being reviewed continually, and research projects enable the latest techniques to be evaluated so that the testing system can be modified where appropriate.

In addition to the above forensic investigations, DSIR presents scientific evidence at formal commissions of inquiry set up to investigate specific accidents. Examples over the past few years, that have featured in news headlines, are the defoliant chemical spill in Parnell (Auckland) in February 1973, the accident to a ferris wheel in Palmerston North in August of the same year, the fatal explosion and fire at Seaview (Hutt Valley) in September 1974, and the fire in an aircraft cargo compartment at Christchurch Airport in April 1975. In all of these inquiries, the DSIR evidence has played a key role in establishing the cause of the accident, and in guarding against recurrence.



The Vanda Weir, where the flow of Antarctica's only river, the Onyx, is recorded. This river, in the Wright Valley, flows for only two months each year. The buildings in the distance are Vanda Station.

DIVISIONS AND BRANCHES

ANTARCTIC DIVISION

Union Centre Buildings, 241A Oxford Terrace, Christchurch
POSTAL ADDRESS: P.O. Box 2110, Christchurch
TELEGRAMS: ANTARCTIC Christchurch TELEPHONE: 65-349 Christchurch
SUPERINTENDENT: R. B. Thomson, OBE
STAFF at 31-3-76: 4 science technicians and 25 supporting staff.

When it was decided that New Zealand activity in the Antarctic should continue for an indefinite period after the end of the International Geophysical Year (I.G.Y.) activities in December 1958, the Ross Dependency Research Committee (R.D.R.C.) was formed to advise the Minister in Charge of the Department of Scientific and Industrial Research on the Antarctic programmes to be carried out. This also required the establishment of a separate Antarctic Division within DSIR, in May 1959, to co-ordinate and implement all New Zealand Antarctic activities. Its detailed functions are:

(a) to be responsible for the execution and operation of Antarctic scientific activities approved by the Minister;

(b) to supervise approved Government and non-Government expeditions to Antarctica;

(c) to maintain an information centre on Antarctic scientific research and exploration;

(d) to implement New Zealand Government policy regarding all non-scientific activities in Antarctica. This includes control of tourism and compliance with regulations in the Antarctic Act (1970) and with international agreed measures for the conservation of Antarctic fauna and flora.

On 1 January 1970 Antarctic Division transferred to Christchurch and, in addition to its principal functions, assumed servicing responsibilities previously held by District Office. These include the provision of clerical and stores servicing and an administrative consultative service for other DSIR units in the Christchurch area.

The Division's permanent strength in Christchurch is 21, but temporary staff employed by the Division for service in Antarctica increases this number to aproximately 60 during peak summer activity. A total of over 120 people (including worker visitors and university expeditions) are engaged annually in the New Zealand Antarctic Research Programme.

ANTARCTIC BASES

New Zealand maintains one main base (Scott Base) in the Ross Dependency, Antarctica; Vanda Station, 130 km to the west of Scott Base; and a summer station at Cape Bird.

Scott Base Pram Point, Ross Island (77° 50′ S, 166° 44′ E)

Scott Base was erected in January 1957 on Pram Point, a low rocky projection on the eastern side of the Hut Point Peninsula near its termination, Cape Armitage. The base consists of 11 huts, linked by a covered way, and ancillary buildings.

Scott Base is manned and operated throughout the year. Usually about 12 people are present during winter, but from October to March each year the population is increased to up to 50 people by summer personnel. Among these are field parties which conduct research in the earth sciences and biology, working in various parts of the Ross Dependency. Staff are also engaged on construction work and special projects in the vicinity of the base.

It is planned to replace the present base over the next five years. In late 1975 the stores hut was demolished to make way for the first building of the new base, a dormitory for about 20 people with a mezzanine floor for scientific work. It is proposed that construction will begin during the 1976–77 summer, with a phased replacement of the whole base. This could take until 1980.

Vanda Station Wright Valley (77° 31′ 25″ S, 161° 40′ 23″ E)

Vanda Station, New Zealand's only base on the Antarctic continent, was constructed during the 1967–68 summer. It is situated near Lake Vanda in the Wright Valley, one of the ice-free "Dry Valleys" Additional huts were built during the summer of 1968–69, to provide sufficient facilities for the first wintering-over party in 1969.

The establishment of this small base resulted from intense scientific interest in the Dry Valley area and its warm lakes and climatic peculiarities. Vanda Station is manned and operated each summer, and parties wintered-over in 1969, 1970, and 1974.

Cape Bird Ross Island (77° 14′ S, 166° 28′ E)

The hut at Cape Bird was constructed in 1966 on a ledge overlooking the Adelie penguin rookery on the beach. It is used only during summer by biologists from the University of Canterbury, who carry out research in marine biology and study the behaviour of penguins and skuas in the area. In 1971–72 a wet laboratory was constructed to facilitate studies of marine plankton and benthic research.

SCIENTIFIC PROGRAMME

Scott Base is an important link in the global chain of geophysical observing stations. Main research is undertaken in ionospherics, geomagnetism, earth currents, atmospheric potential gradient, seismology, and meteorology. At Arrival Heights, close to Scott Base, equipment collects and records data throughout the year on auroral physics, ionospheric absorption, and geomagnetism.

Since the completion of the geological reconnaissance in 1965 geological research has become more specialised in areas of particular interest, especially in the Dry Valley region. Considerable biological work is being done throughout the Ross Dependency, wherever logistics and support allow it.

Field parties based at Scott Base and Vanda Station for the 1975–76 summer season carried out a limited programme of research in geology, geomorphology, geochemistry, biology, glaciology, hydrology, and volcanology. The reduced size of this season's field programme was caused by the unfortunate loss of a U.S. Navy C-130 Hercules aircraft; this restricted greatly the air support between New Zealand and Antarctica. Summer activity at Vanda Station also included research programmes in meteorology and climatology.

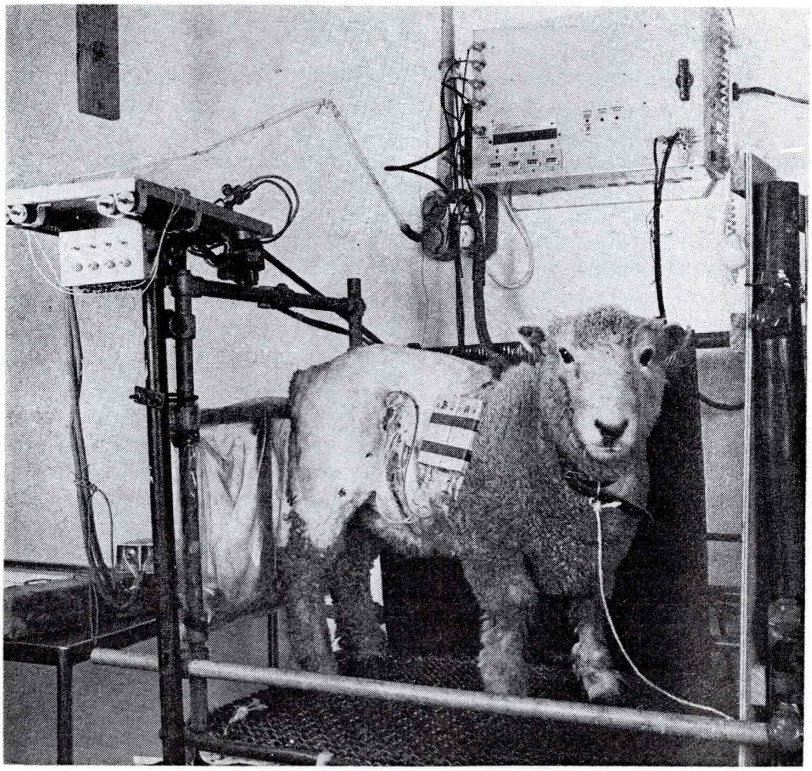
Special short-term projects are often undertaken, depending on the work load on the staff at Scott Base. Such projects for the 1975–76 summer included atmospheric CO_2 sampling, studies of the physiology and psychology of Scott Base staff.

The joint US/NZ/Japanese Dry Valley Drilling Project was completed in December 1975 with the coring of the McMurdo Sound sea-floor from a drill rig mounted on the annual sea-ice. This important project began in the 1972–73 season and has yielded much valuable information on the geological history of Antarctica.

UNITED STATES–NEW ZEALAND RELATIONS

New Zealand and the United States co-operate in pooling and providing logistic support. New Zealand provides facilities and services for the United States to operate from this country, and, in return, the Americans undertake all our air support requirements within Antarctica, mostly by helicopter. The RNZAF contribute as many flights as are necessary to convey New Zealand personnel and material to Antarctica.

This close co-operation has, over the years, caused a satisfactory understanding to develop, considerably easing New Zealand's problems of transportation and allowing more specialists to participate in short-term summer projects.



The pancreas and liver play an important role in the digestion of fat. Two self-regulating pumps attached to the side of the sheep have been developed, not only to measure the flow of pancreatic juice and bile, but also to return these secretions to the small intestine. The dietary and hormonal effects on the composition of pancreatic juice and bile are being investigated.

APPLIED BIOCHEMISTRY DIVISION

Fitzherbert West, Palmerston North
POSTAL ADDRESS: Private Bag, Palmerston North
TELEGRAMS: BIOCHEM Palmerston North TELEPHONE: 68 019 Palmerston North
DIRECTOR: *R. W. Bailey*, PhD *Birm*, DSc *Birm*, FRSNZ.

Cell Biology and Proteins: J. G. Robertson, PhD *Massey*.
Animal Nutrition and Physiology: C. S. W. Reid, PhD *Cantab*.
Carbohydrate Chemistry: R. W. Bailey, PhD *Birm*, DSc *Birm*, FRSNZ.
Plant Biochemistry: P. F. Reay, PhD *Cantab*.
Nitrogen Fixation: R. M. Greenwood, MSc.
Microbiology: R. T. J. Clarke, PhD.
Biophysics: K. I. Williamson, MSc.
Natural Product Chemistry: G. B. Russell.
Protein Nutrition: E. Hove, PhD.

SITE AND CLIMATE

Lat.: 41° 23' S *Long.:* 175° 37' E
Alt.: 32 m
Soil type: Manawatu silt loam
Rainfall: Average 995 mm per annum on 180 days, distribution even, occasional late summer drought. Mean evaporation 787 mm.
Temperature: Mean max. 16.6°C; mean min. 8.3°C.
Days with ground frost: 66
Hours of sunshine: 1800

SUBSTATION

LINCOLN:
c/- Crop Research Division, DSIR
J. D. Ferguson, PhD.

STAFF at 31-3-76: 44 scientists, 48 science technicians, and 11 supporting staff.

Applied Biochemistry Division is concerned with the nutritional evaluation and acceptability of forages and human foodstuffs, and with some aspects of grassland and crop productivity, including photosynthesis and symbiotic nitrogen fixation. The core disciplines are biochemistry and nutrition, with supporting disciplines in ruminant physiology, microbiology, and the chemistry of natural products.

Current projects

MINERAL NUTRITION OF PLANTS AND ANIMALS: Nutrition and cycling of trace elements; chemical binding and availability of minerals in forages and foodstuffs.

PROTEIN AND NUCLEIC ACID BIOSYNTHESIS: Studies of regulation of protein and RNA synthesis in plant tissue.

CELLULAR DEVELOPMENT: Changes in cells during differentiation; membrane biogenesis in legume nodules.

NITROGEN FIXATION: Biochemical, microbiological, and ultrastructural studies of symbiotic nitrogen fixation in legume root nodules; classification of rhizobia organisms.

PLANT CARBOHYDRATES: Changes in composition of plant cell walls during development; mechanisms of biosynthesis of cell-wall constituents; seaweed polysaccharides; utilisation of sawdust and bark waste.

PROTEIN NUTRITION: Extraction and utilisation of leaf and seed proteins; evaluation of nutritive value of food and forage proteins.

UNUSUAL PLANT CONSTITUENTS: Plant phenolics, especially tannins; cyanoglucosides and glucosinolates; oestrogenic substances in pastures; insect hormones and toxins in native plants; toxic compounds from pasture fungi.

MICROBIOLOGY: Microbiology of digestive tracts of ruminants, opossums, insects; scanning electron microscope studies of rumen wall and bacteria; microbial degradation of wastes and generation of methane.

RUMINANT NUTRITION, METABOLISM, AND PHYSIOLOGY: Nutritional value of pasture plant strains; unorthodox ruminant feeds; digestion and absorption of feed components in various regions of the ruminant gut; bloat in cattle; lucerne red gut in sheep, excess fat in sheep.
LIPIDS: Lipid composition of ruminants, rhizobia, and seeds; ruminant lipid metabolism; mono-methyl branched fatty acids in the ruminant
FLAVOUR: Identification of mutton flavour components.
CROP BIOCHEMISTRY: Plant/insect relationships, including resistance to aphids, grass grub, and porina; abscisic acid effects on crop plants; agronomic and physiological factors affecting lupin seed yields; methods for screening plant populations for chemical characteristics.

HISTORY AND ACTIVITIES

It was recognised in the 1930s that although studies of mineral constituents of herbage were a vital part of New Zealand's agricultural research programme, they did little to explain seasonal metabolic disorders such as bloat, facial eczema, and 'staggers'. All these appeared to be linked to the abnormal growth of pasture plants. The Plant Chemistry Laboratory was established at Palmerston North in 1938 to study this problem, particularly because of the heavy outbreak of facial eczema in the autumn of that year. During World War II the Laboratory was engaged mainly on vegetable dehydration and the facial eczema programme lapsed because of staff shortages. After the war facial eczema investigation was taken over by the Department of Agriculture and Plant Chemistry Laboratory turned its attention to bloat, and detailed studies of pasture composition and growth, under Dr J. Melville.

In 1951 the Laboratory became part of Grasslands Division with Dr Melville as Director. When he left in 1956 the Plant Chemistry part of Grasslands Division was again separated, as a new division, Plant Chemistry Division, under the direction of Dr A. T. Johns.

During the 1950s the Division began its major contributions to the understanding of the causes of bloat, and the means of its prevention and control. In the early 1960s began the long series of studies on the underlying relationships between herbage quality and animal growth, associated with Grasslands Division's plant breeding programme.

In 1965 the biochemistry group of Crop Research Division at Lincoln was transferred to Plant Chemistry Division as a sub-station, appropriately placed to serve as an input point for biochemical problems associated with crops.

In 1969 whilst under the direction of Dr G. W. Butler (appointed 1965), the Division's name was changed to Applied Biochemistry Division. This was in part a recognition of the broadening of the scientific interests and activities of the Division and also coincided with the amalgamation with Food Chemistry Division following Dr F. B. Shorland's retirement. Dr R. W. Bailey took over as Director in 1974.

Applied Biochemistry Division can now be said to be concerned with 'mission-oriented', in-depth research on various aspects of the plant-animal interaction; the animal being usually, but not always, a ruminant and the plant usually, but not always, grown to be eaten by an animal.

APPLIED MATHEMATICS DIVISION

7th Floor, Rankine Brown Building, Victoria University of Wellington,
Kelburn, Wellington
POSTAL ADDRESS: P.O. Box 1335, Wellington
TELEGRAMS: RESEARCH Wellington. TELEPHONE: 727 855 Wellington
DIRECTOR: H. R. Thompson, PhD *Manch.*

Mathematical Statistics: J. H. Darwin, BA *Cantab,* PhD *Manch.*
Mathematical Physics: A. McNabb, BA *Cantab,* DSc *Vic.*
Operational Research: H. Barr, PhD *Toronto.*
Computer Software Development: M. J. Newman, BSc.
Computer Engineering: A. M. Surti, MSc *Wales.*
Library: P. J. Sallis.

SUBSTATIONS

AUCKLAND: c/- Mt Albert Research Centre. S. A. Tucker, MSc.
PALMERSTON NORTH: c/- Grasslands Division. V. J. Thomas, BA, MSc.
LINCOLN: c/- Crop Research Division. E. Stevenson, BSc.
STAFF at 31-3-76: 44 scientists, 4 science technicians, and 17 supporting staff.

Applied Mathematics Division (AMD) provides a research and advisory service in those branches of applied mathematics that are of economic and scientific value to New Zealand. A central theoretical group in Wellington advances the study of applied mathematics and its application to biological and physical sciences, agriculture, industry, etc. An applied group, with members in Wellington and others attached to divisions at Auckland, Palmerston North, and Lincoln, copes with day-to-day problems of DSIR, and provides a service to other Government departments, universities, business, and industry.

The Division operates a scientific computing bureau for DSIR divisions (which use about 60% of the total time) and other, mainly Government-funded, users. The system consists of an Elliott 503 (8K 39-bit words) with 32K backing store, 6 magnetic tape units, card reader, two high-speed lineprinters, and digital plotter. AMD also has a Hewlett-Packard 2100A minicomputer (HP) with 32K 16-bit words and twin discs, for linking the Wellington branches of DSIR to a larger computing facility than the Elliott, and providing conversational mode computing for scientists.

A group of mathematicians formed the nucleus of the division around 1946, under the name Biometrics Section. This became the Applied Mathematics Laboratory in 1949, and Applied Mathematics Division in 1964. In 1965 AMD moved to a permanent home adjacent to the Mathematics Department at Victoria University of Wellington. There were many reasons for this move: a community of research interests in theoretical and applied statistics, fluid mechanics and heat flow, operational research, and other areas of application of mathematics; more fruitful discussions and collaboration with a wider group; better chances of retaining staff; and joint use of the computer. The move has been amply justified on all these counts, and close co-operation has also developed with the Department of Information Science in O.R. and computer science and the Computing Services Centre in software systems augmentation and computer network development.

SECTIONS

Mathematical statistics

The section is concerned with design and analysis of experiments and surveys, and building models of the behaviour of scientific and other systems. It handles results of biological analyses, including population studies, and chemical and geophysical studies of the relationships between several variables. The main statistical techniques required are regression and analysis of variance, multivariate analysis (including numerical taxonomy), and the analysis of processes that develop in time and space and exhibit random as well as deterministic behaviour.

There is an increasing emphasis on social statistics in justice, housing, and social welfare. In such areas multivariate techniques, designed to reduce a mass of data to a small number of meaningful statistics, are important.

Major theoretical work is on the power of statistical tests to detect departures from assumed theory, the large sample analyses of time series (especially those that show a time-related dependence of one set of readings on the previous set), and the development of accurate computer programs for regression analysis.

Mathematical physics

The section is primarily concerned with constructing and analysing mathematical models relevant to various scientific, engineering, and geophysical problems. This requires specialist knowledge of branches of continuum mechanics such as elasticity theory, fluid mechanics, and mass transport theory. Explicit solutions are rare, and approximation theory plus allied techniques, such as asymptotic theory or perturbation theory, are important.

Most current research is directed towards understanding the reservoir mechanics of the Wairakei geothermal power project, and wider geophysical problems of the formation and behaviour of thermal regions in general. This research may give a better understanding of geothermal power resources available in New Zealand and more efficient means of exploiting them.

Operational research

Operational research (O.R.) is concerned with scientific collection and analysis of information to aid management decision-making. Questions like the best method of operation for a production line or of scheduling a fleet of vehicles can be considered. Planning decision problems such as choosing between alternative future facilities to meet demand, where uncertainty and risk must be taken into account, can also be analysed. Usually the essentials of the system or operation are abstracted and expressed as a mathematical model. The model, rather than the real system, can then be investigated to find how it responds to alternative situations.

The section offers a consultant service on O.R., mathematical modelling, and systems analysis problems. This has been used by industry and also by central and local Government. Recent projects include: methods for timetabling passenger vehicles, assistance in a feasibility study for a new industry, modelling the cash flows of a superannuation scheme, metropolitan public passenger transport modelling, assistance in site location for rubbish disposal facilities, and assistance in the development of national transport policy models.

In the future, the section hopes to assist the transport, distribution, and manufacturing sectors in particular. The section will also advise on computer programs for linear and non-linear optimisation and on computer simulation.

Software development

The section has two main interests. One is systems programming, i.e., providing basic programming facilities to enable efficient but flexible use of the computer and its peripheral equipment. An example is the proposed production of a text-editing and remote-job-entry system for the HP2100A computer. This will enable users to generate and maintain magnetic disc files from a keyboard connected to the computer, and to prepare jobs for execution. Jobs so prepared may be directed to a remote computer (or possibly one of several), where they will be executed, with output returned to the local system.

The second major interest is providing user-oriented facilities such as generalised programs and packages of procedures. Both interests are designed to make the computer more easily available to the casual user. Other fields of interest are linear and dynamic programming, library automation, and information retrieval.

Computer engineering

The engineering section maintains the Elliott 503, Hewlett Packard 2100A, and associated on-line equipment. It advises users on in-field data acquisition, distribution, and transmission as well as hardware formatting. Help is given to users in the design and construction of specialised device interfaces and equipment for on-line computation. Projects planned or under way relate to optical digitisation, hybrid computation, keyboard-entry TV consoles, active and interactive terminals, the use of minicomputers as active links to large computers and as universal controllers, optical and acoustic couplers for data communication, computerised film animation, microprocessor applications, simulation and model study of networks, and advice on selection of computer peripherals.

To assess the noise levels expected in trains for the proposed Auckland rapid transit system, AIDD is taking sound measurements in some representative vehicles on a variety of track conditions. The upper photo shows sound measurements being made in the 'Silver Fern' railcar, while passing through the Parnell Tunnel; the lower shows monitoring of rail noises in the driver's compartment.

AUCKLAND INDUSTRIAL DEVELOPMENT DIVISION

Chandris House, 9–11 Albert Street, Auckland 1
POSTAL ADDRESS: P.O. Box 2225, Auckland
TELEGRAMS: AIDEL Auckland TELEPHONE: 34-116 Auckland
DIRECTOR: W. R. Beasley, CEng, MIMechE.

Administration Officer: M. R. Glennister.
Design Engineering and Product Development: B. H. Hodder, CEng, MIMechE.
Electronics and Acoustics: J. B. Cornwall, CEng, MIEE.
Liaison and Information: F. Puch, CEng, MIMechE.
Mechanical and Production Engineering:
Metallurgy: P. E. Thomas, BSc(Hons).
Physics and Applied Heat: G. H. Palmer, MSc; R. W. Foster, CEng, MIMechE, MNZIE.

STAFF at 31-3-76: 27 scientists, 38 science technicians, and 13 supporting staff.

The Division (AIDD) promotes efficient industrial use of raw materials, machines, production techniques, and human resources by encouraging the wider application of research results, the use of standard specifications and practices where applicable, and the use of precision measurement and data analysis, particularly in mechanical engineering, metallurgy, physics, and electronics.

Results of research and development are disseminated by direct assistance to industry; by liaison activities such as lectures, seminars, and conferences; and by production and distribution of reports, articles, and leaflets.

Current projects

AGRICULTURE: effect of storage conditions on kiwifruit, maize, potatoes, and other fruit and vegetables; design and testing of commercially sized storage facilities for produce; design and performance testing of maize-, lucerne-, and onion-drying installations; instrumentation to detect foetal death in sheep; assistance to Meat Industry Research Institute with meat-conditioning experiments.

BUILDING AND CONSTRUCTION: evaluation of acoustic insulation of building-construction methods; advice on acoustic design of rooms; evaluation of building-construction noise and its reduction; calibration of soil- and clay-testing equipment; evaluation of roof-guttering system, load capacity of fasteners for concrete, structural properties of roof and floor sections, and strength and resistance to seismic loads of large switchgear cabinets.

HUMAN HEALTH: assisting commercial production of radio-telemetry equipment for use in medical and animal physiology applications; investigation of a system for monitoring the foetus in several patients simultaneously; development of apparatus for automatic epidural injections at set intervals; portable patient-borne recorder for monitoring heart beats over 24-h period, apparatus for recording intracranial pressure, apparatus for urine flow measurement, apparatus for use with acupuncture investigations, and low-cost fluorimeter for body fluids.

MANUFACTURING INDUSTRY: *Design* – worm and gear reduction boxes; trailer suspension components; low-cost ball races; portable winches; air compressors; tower crane bolt tests; hydraulic system components; furnace element design; design of infra-red switch; electronic taximeter evaluation; assisting Industrial Design Council to evaluate locally manufactured products; design and quality control of vehicle components; design investigations into machines, products, and equipment in industry; evaluation of physical and mechanical properties of plastics and synthetic engineering materials; evaluating flow characteristics of gas and fluid control valves and testing to fire-rating specifications; use of CO_2 laser to evaluate industrial applications; and study of electrostatic properties of materials. *Metallurgy and metallurgical services*—assistance to manufacturers in overcoming production problems in metal-finishing, corrosion, engineering metallurgy, materials selection, heat treatment, welding, and casting; facilities for mechanical testing, metallographic examination, and heat treatment; chemical analysis laboratory services; access to scanning electron microscope and electron-beam microprobe analyser at the University of Auckland; reclamation of aircraft engine castings; casting of alloy road wheels; investigating stress-corrosion failures; plating-effluent treatment; anodic protection of steel vessels; thermo-mechanical strengthening of ferrous materials; brittle fracture investigations; quantitative measurement and evaluation of zinc die-casting variables; problems relating to lamellar tearing of heavy steel sections during fabrication by welding; waste-recycling program; extrusion, forging, and forming problems. *Production engineering* – computer-assisted numerical control tape preparation; textile quality control; process capability studies; production-line quality control; value engineering; sawing aluminium; threading of drill casing; thread rolling; machining hardened steel; stump-chopping machine cutter; tool wear in machining manganese steel; developing skiving tool theory; cutting-tool research and application to production problems; development of high-pressure hydraulic and pneumatic testing facilities; noise-control engineering in industrial plant. *Engineering metrology* – measuring components, tooling, and gauges; calibrating industrial measuring instruments; aligning production machines and machine tools; laser interferometry calibration of machine-tool measuring systems. *Mechanical engineering* – measurement of most engineering variables; consultancy service in vibration and stress analysis; isolation of ground vibration from foundations of grinding machines; crane stress and load measurement; pressure-vessel stress analysis; press stress analysis; fatigue tests on special-purpose components. *Physics* – development of calibration facilities for temperature, humidity, and flow.

NATURAL RESOURCES AND ENVIRONMENT: monitoring atmospheric conditions in Waitomo caves; developing theory for geothermal fields; reduction of noise in locomotives and earthmoving machines; advice on design of automotive, truck, and motorcycle silencers; reducing noise and assessing speech intelligibility in schools.

HISTORY AND ACTIVITIES

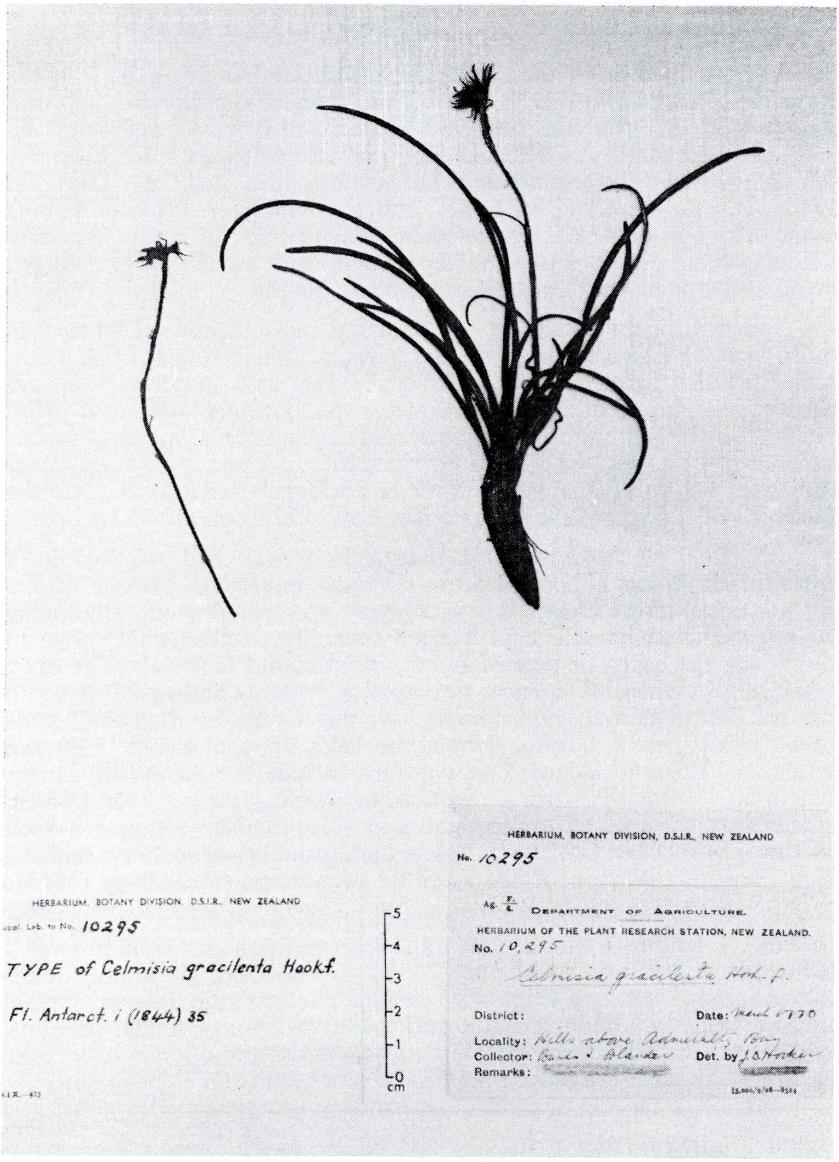
AIDD developed from the Auckland Industrial Development Laboratories (AIDL), established in October 1945 under the direction of John Brooke (A. W. Melville became Director on Brooke's retirement in 1971). Initial staff was selected from several wartime laboratories — mainly the Radio Development Laboratory, the Auckland Technical Development Committee of DSIR, and the Dominion Physical Laboratory. The aim of AIDL was to make available to a rapidly expanding manufacturing industry the wartime experience gained in metrology, gauging, production techniques, and product quality.

Laboratories were set up for electrical and electronic engineering, mechanical engineering design, and physics. Their original functions, viz., providing a research service to and acting as a source of technical advice and information for industry, collaborating with university colleges in the promotion of research and development, and carrying out defence projects for the Armed Services have not changed greatly over the years (except that defence work is no longer undertaken), but the methods of achieving these objectives have been constantly revised.

By 1950 demands for metallurgical services had resulted in a metallurgist being appointed from overseas and establishment of the metallurgy section. Today, this is a highly specialised group employing sophisticated equipment, e.g., using a scanning electron microscope to determine the cause or type of failure in industrial materials. The early fifties also saw AIDD's early attempts at forming industrial research groups. The first successful co-operative effort was the Medical Instrument Development Group, formed in 1952, in conjunction with the Auckland Hospital Board. Other groups include the Acoustics Group, a spin-off from the Electronics Section; the NZ Institute of Foundrymen, started as a foundry technology group in 1953; the New Zealand branch of the Australasian Corrosion Association, established in 1959; and the New Zealand Division of the Institute of Materials Handling (1965).

AIDD and the then Fruit Research Division began an investigation in 1963 of optimum storage and transport conditions for fruit and vegetables. In co-operation with the NZ Apple and Pear Marketing Board and shipping lines, two ships were instrumented to monitor temperature and humidity conditions of fruit during the voyage to Europe; the ships carried a divisional scientific officer to supervise the operation. Results of this work have since been applied to other fruits and vegetables.

Increased assistance to the manufacturing industries over the last decade, resulting from a study by NRAC, led to the Division's engineering services becoming a growth point: a TELARC-registered Engineering Metrology Laboratory has been established to provide a precision measuring and calibration service; the Engineering Dynamics Laboratory investigates problems in machine installation, alignment, and calibration; the Production Engineering Group deals with machining and metal forming; the Industrial Engineering Group advises on quality-control systems; and the Design Section covers product development and performance evaluation. These factors enable the Division to provide an even more efficient scientific service to industry.



HERBARIUM, BOTANY DIVISION, D.S.I.R., NEW ZEALAND

ppl. Lab. to No. 10295

TYPE of Celmisia gracilenta Hookf.

Fl. Antarct. i (1844) 35

.I.R.—473

HERBARIUM, BOTANY DIVISION, D.S.I.R., NEW ZEALAND

No. 10295

Ag. F./4. DEPARTMENT OF AGRICULTURE.

HERBARIUM OF THE PLANT RESEARCH STATION, NEW ZEALAND.

No. 10,295

Celmisia gracilenta Hook. f.

District: Date: March 1770

Locality: Hills above Admiralty Bay

Collector: Banks & Solander Det. by J. D. Hooker

Remarks:

15,000/5/28—8514

This historic specimen of *Celmisia gracilenta* was collected by Joseph Banks and Daniel Carl Solander on Cook's first voyage to New Zealand. The specimen is one of 275 000 in the Botany Division Herbarium, which provides scientists with permanent reference material and ecological information.

BOTANY DIVISION

Lincoln
POSTAL ADDRESS: Private Bag, Christchurch
TELEGRAMS: BOTANY Christchurch TELEPHONE: 8019 Halswell
DIRECTOR: E. J. Godley, PhD *Cantab,* FLS, FRSNZ.
ASSISTANT DIRECTOR: H. E. Connor, MSc.

SECTIONS

Ecology and Vegetation Surveys: P. Wardle, PhD *Cantab.*
Palynology and Anatomy: N. T. Moar, PhD *Cantab,* FLS.
Taxonomy: H. E. Connor, MSc.

SUBSTATIONS

AUCKLAND: c/- Mount Albert Research Centre. A. E. Esler, MAgrSc.
TAITA: c/- Soil Bureau, A. P. Druce, BE.
NELSON: DSIR, Private Bag, Nelson. G. N. Park, PhD *ANU.*
DUNEDIN: P.O. Box 5036, Dunedin. P. N. Johnson, PhD *Otago.*

STAFF at 31-3-76: 26 scientists, 17 science technicians, and 7 supporting staff.

Botany Division studies the vegetation and describes and classifies native, naturalised, adventive, and horticultural elements of the New Zealand flora. Correlated research is carried out in genetics, cytology, anatomy, morphology, palynology, and ecology.

The Division houses New Zealand's largest herbarium (International Code, CHR; Keeper, Dr D. R. Given), which contains about 275 000 specimens of seaweeds, lichens, mosses, liverworts, ferns, and higher plants. An experimental garden of 9 hectares is complementary to all studies.

Current Projects

TAXONOMY: *Flora of New Zealand,* Vol. III (naturalised monocotyledonous weeds), Vol. IV (grasses), and Vol. V (naturalised dicotyledons); general taxonomic studies of lichens and freshwater and marine algae; specialist revisions of *Celmisia* and Australasian *Luzula;* chemotaxonomic studies of *Cortaderia, Chionochloa,* and *Carmichaelia.*

GENETICS: studies on reproductive systems in New Zealand plants, including incompatibility, apomixis, and the genetics of male sterility.

APPLIED BOTANY: identification of plants, especially weeds of crops, pastures, and waterways; advice on legislation concerning plants; recommendations about plant introduction; advice on poisonous plants.

PALYNOLOGY AND QUATERNARY ROTANY: preparation of a handbook describing pollen grains of New Zealand gymnosperm and dicotyledonous plants; studies of late Quaternary vegetation and climate history by pollen analyses and the identification of sub-fossil wood and charcoal.

ANATOMY: wood anatomy of New Zealand dicotyledonous plants; preparation of a handbook describing the wood anatomy of indigenous shrubs and trees.

ECOLOGY AND CONSERVATION: survey of all reserves and some national parks; basic ecological research, including the ecology of sand dunes, the nature of the boundary between beech–podocarp and podocarp–hardwood forest in Westland, the autecology of podocarp species, and the causes of alpine timberline.

HISTORY AND ACTIVITIES

Botany as a science was formally organised in DSIR by the appointment of Dr H. H. Allan as systematic botanist to the Plant Research Bureau in 1928. Systematic botany, or taxonomy, has formed a major part of Division activity, and the first two volumes of the *Flora of New Zealand* were the direct result of 30 years' work in taxonomy, ecology, and floristics. Early studies also resulted in *An Introduction to the Grasses of New Zealand* (1936, DSIR Bulletin 49) and *A Handbook of the Naturalised Flora of New Zealand* (1940, DSIR Bulletin 83); both are out of print and are being replaced.

The Division has long been involved in weed identification, weed legislation, and precautions against possible future weeds. Detailed autecological studies of weeds in the 1930s and 1940s lead to DSIR Bulletins on ragwort, *Senecio jacobaea,* and nassella tussock. Water plants are one of the main weed problems of very recent times, and the Division has published guides to assist in the recognition of this important class of weeds.

Ecological studies developed later than taxonomic work, but concern about New Zealand's badly eroded landscapes lead to research on the indigenous grasslands, their origin, development, and deterioration. The task of describing the natural grasslands continues today. After Molesworth Station in Marlborough reverted to the Department of Lands and Survey, Botany Division staff studied changes in vegetation over 30 years. In this project the Division was actively involved in plant introduction for the first and only time. Currently it acts as a recording centre, listing those plant species and cultivars that are imported.

Transformation of the New Zealand landscape is proceeding at a faster rate, and the changes are more fundamental than ever before. Another long-term project being performed by Botany Division is the botanical survey of New Zealand's scenic reserves and four of the national parks (Tongariro, Egmont, Nelson Lakes, and Westland). Consequently, nature conservation has taken on a new urgency, with information on the distribution and species content of plant communities as a basic requirement. Species that are becoming rare must be recognised as such before they can be protected; a register of threatened plants is being progressively compiled.

About 80% of the 2000 native species of vascular plants are restricted to New Zealand ,and this has offered a wide range of opportunities for specialised cytological and genetical studies. A "Chromosome Atlas of the New Zealand Flora" was begun in 1958, and chromosome numbers of 530 taxa from 118 genera have been published.

Studies in the field of vegetation and climate history have been and still are required by botanists, geologists, pedologists, and archaeologists. Following on from the classic studies of Cranwell and van Post in 1936, regional studies have emphasised the complexity of post-glacial patterns of vegetation, Events in the development of these patterns can be timed by radiocarbon assay. For example, it is now known that the podocarp–beech transition was not a synchronous event in the South Island, and that a significant change in vegetation occurred everywhere about 10 000 years ago, at a time of marked warming of the climate.

CHEMISTRY DIVISION

Gracefield Road, Lower Hutt
POSTAL ADDRESS: Private Bag, Petone
TELEGRAMS: CHEMDIV Petone TELEPHONE: 666 919 Wellington
DIRECTOR: A. J. Ellis, PhD *Otago*, FRSNZ, FNZIC.

DEPUTY DIRECTOR: T. Marshall, BSc, BE, FNZIC, AOSM, AIME.
Organic Materials; Chemical Engineering; Geochemistry; Geothermal; Metallurgy; Mineral Processing; Physical Chemistry; Industrial Chemistry; Process Development.

DOMINION ANALYST: I. R. C. McDonald, MSc, FNZIC, ARIC.
District Laboratories; Pharmaceuticals and Water; Forensic; Organic Chemistry; Applied Chemistry; Food and Pesticides; Toxicology.

Administrative Officer: J. T. Milne.

DISTRICT LABORATORIES

AUCKLAND: Broadcasting House, Durham Street West. P.O. Box 2224. Telegrams: CHEMDIV. Telephone: 379 987.
Government Analyst: D. F. Nelson, MSc, DCrim *Cal*, FNZIC.

WAIRAKEI: State Highway 1, Wairakei. Postal Address: c/- Ministry of Works, Private Bag, Taupo.
Officer in Charge: W. A. J. Mahon, MSc, ANZIC.

CHRISTCHURCH: Government Buildings, Worcester Street. P.O. Box 2112. Telegrams: CHEMDIV. Telephone: 65 419.
Government Analyst: G. R. Scott, MSc, FNZIC.

STAFF at 31-3-76: 155 scientists, 75 science technicians, and 50 supporting staff.

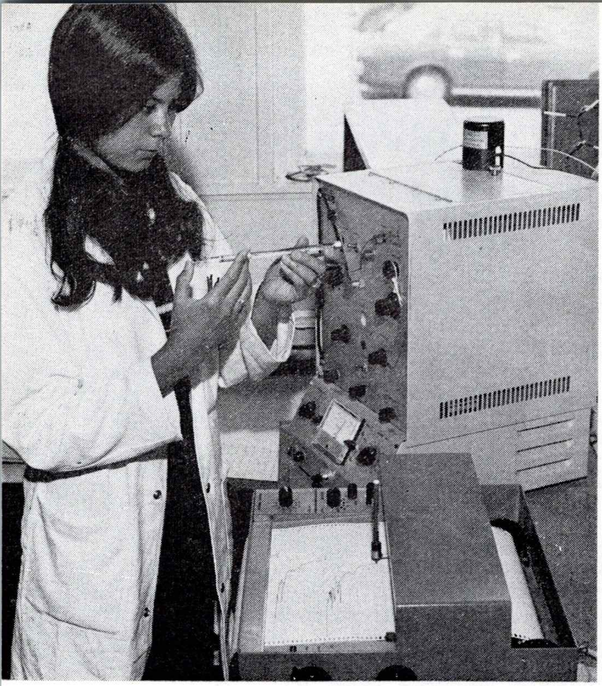
The main functions of Chemistry Division are: to undertake long-term chemical, metallurgical, and chemical engineering research important to development of the resources and social needs of New Zealand, wherever possible anticipating future requirements for technical knowledge; to carry out investigations aimed at raising the efficiency of New Zealand industry, both private and state, and to promote new industries; to serve as a central laboratory for the chemical, metallurgical, and chemical engineering requirements of Government departments, undertaking specific work and co-operating in joint projects; and to encourage the growth of organisations, both Government and private, able to supply improved technical services to industry.

Current Projects

(A complete account is available in: Chemistry Division 1974 Handbook, *N.Z. DSIR Information Series No. 98*. 1974.)

FOOD AND PHARMACEUTICALS: analysis of foods to ensure compliance with the Food and Drug Regulations (1973); suitability and safety of containers for food and drugs; toxic elements and pesticide residues in the New Zealand diet; dissolution of oral dosage forms of drugs; drug transport through membranes; *in vivo* comparisons of competing brands of drugs; drug stability trials; particle counts in parenteral solutions; honey quality; pottery glaze compositions.

PESTICIDES: monitoring pesticide levels in food; determination of pesticide residues in fruit and vegetables; persistence of lindane insecticide in pasture soils; production of experimental water-dispersible formulations of short-lived insecticides for grass-grub control.



As part of the pathologist's investigation of the cause of unexplained death, chemical analyses of samples from the body may be requested to determine whether drugs or poisons are involved. One of the techniques used by Chemistry Division in this work is gas chromatography; photo shows a liquid sample being added to the gas chromatograph.

ORGANIC CHEMISTRY: wood chemistry studies; solasodine recovery; lanolin chemistry; the yields and compositions of New Zealand-produced sunflower and rape oils; analysis of chemical constituents to confirm classification of primitive native plants; development and application of new chemical analysis methods (e.g., gas chromatography/mass spectrograph); co-ordination of DSIR work on waste utilisation.

WATERS: investigation of water-supply quality and pollution incidents; analytical methods development and inter-laboratory testing (the CHEMAQUA programme); potable water treatment; chemistry of the upper Waikato River and of the Heretaunga and North Canterbury Plains aquifers; land disposal of effluents; precipitation inputs to lakes; Pauatahanui Inlet water quality.

FORENSIC AND TOXICOLOGY SCIENCE: identification of illicit drug seizures; examination of physical evidence submitted by the Police Department; analysis of post-mortem samples of human organs; blood grouping, including Rh-factor and iso-enzyme tests; identification of tool marks; specialist photography; therapeutic drug levels in blood; Transport Act samples for blood alcohol.

GEOCHEMISTRY AND GEOTHERMAL: inorganic analysis of geologic materials; rock and mineral analyses; monitoring and elucidation of hydrothermal phenomena involved in geothermal power production; mechanisms of heavy metal and mineral transport and deposition in geothermal waters; spectrophotometry of high-temperature sulphur-containing solutions; investigation of volcanic fluids and gases; chemical engineering studies of two-phase flow; environmental geochemistry; use of hot waters from geothermal and thermal power stations.

INDUSTRIAL AND MINERAL PROCESSING: processing ironsand concentrates; processing of Christmas Island rock phosphates; investigation of petrochemicals production; recovery and recycling waste materials; advisory work on energy production, efficient energy use, petrol substitutes, and use of waste heat; pollution abatement; silica removal and calcium silicate production from geothermal water; co-operative research on production of gold and other minerals; extraction and processing of peat and lignite wax; extraction and processing of tall oil, resins, and waxes from bark and solasodine from solanum; processing of lime oil; processing of agricultural products such as leaf protein and essential oils.

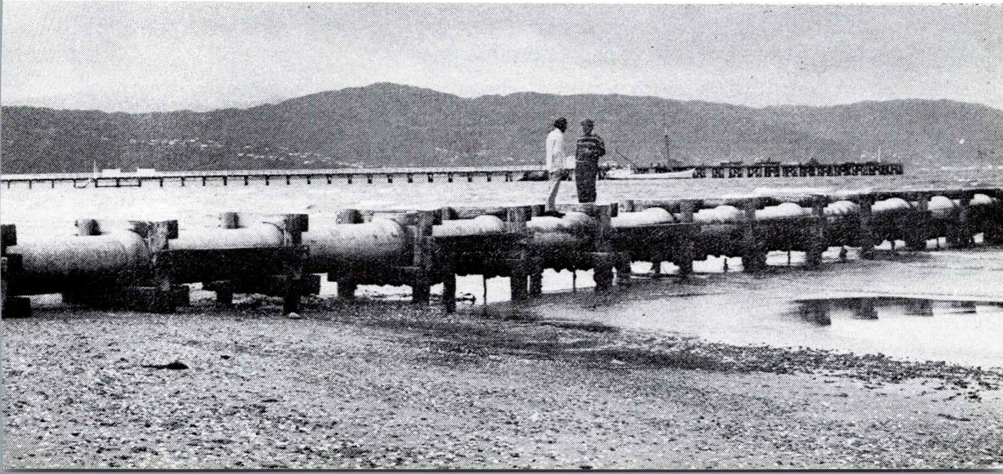
MANUFACTURING: fertiliser production; investigation of silicon ferro-alloy production; recovery of lanolin from woolscour effluent; quality assurance of manufactured products; assessment of products for Government purchase contracts; preparation of specifications for paints, soaps, etc.; deterioration of car seat belts in sunlight and in service; advisory work for the New Zealand electroplating industry.

BUILDING AND CONSTRUCTION: protection of structural steel against corrosion; weather resistance of paint and varnish; performance of plastics, adhesives, and plastic-coated fabrics; cladding systems and attachment of exterior trim to high-rise buildings; investigations on cement, concrete, pumice concrete, aggregates, and fly-ash concrete.

METALLURGY: corrosion, stress corrosion, and fatigue behaviour of metals in geothermal fluids; non-destructive testing of metal components and structures to minimise failures in service; production of resin-coated silica for foundry shell moulding; advisory work on high-density baling of wool; quality of cans and canning methods for foodstuff containment; investigation of service failures of metal components and structures to help avoid recurrence of failures; advisory work for the New Zealand foundry industry.

PHYSICAL CHEMISTRY: crystal growth under controlled conditions; electron spin resonance and Mössbauer spectroscopic studies of minerals and metallo-organic compounds; crystallographic studies of drugs and natural organic compounds; tracing sources of toxic metals with emission spectroscopy; formation of activated carbon from waste bark and

Chemistry Division has investigated several instances of cracking in unburied concrete pipes. Preliminary results suggest that varying temperatures put stress on the pipe, leading to cracking, followed by corrosion of the steel reinforcement, and ultimate failure of the pipe.



coal; computer modelling of geothermal down-hole conditions; statistical analysis of blood alcohol analytical results.

HISTORY AND ACTIVITIES

The Colonial Laboratory was established in 1865 to analyse New Zealand minerals. In the early 1900s the Laboratory moved from Museum Street, Wellington, to a site in Sydney Street, and it was renamed the Dominion Laboratory in 1907, when New Zealand became a Dominion. The Laboratory became part of the Department of Internal Affairs in 1909, but later, in 1926, administration was transferred to the newly established DSIR, and the name changed to Chemistry Division in 1964.

Work of the Dominion Laboratory increased rapidly as Government departments, particularly the Department of Health, realised the importance of chemical techniques; branch laboratories were opened in Auckland (1924), Christchurch (1925), and Dunedin (1927; closed 1973). In the early 1950s a laboratory was established at Wairakei to work on the development of geothermal energy and to undertake volcanological surveys.

Scientific research is undertaken to promote the economic exploitation of national resources and to develop new scientific techniques applicable to the study of local problems. Such research has assisted the development of industries based on clay, cement, limestone, iron and steel, and wood.

More diverse research projects include studies of corrosion in top-dressing aircraft caused by fertiliser mixtures; investigations of the spontaneous combustion of wool to prevent shipboard and wool-store fires; investigation of cement-aggregate interactions in concrete to improve construction methods, especially for dams; studies of the methods of extraction of waxes from peat beds, and their purification; investigation of spray residues on fruit; chemical engineering, corrosion, and geochemical studies to aid the economic development of geothermal power.

Government and private consumers are protected by the Division's work on the quality of food, water, and drugs sold in New Zealand, on a wide range of materials purchased by Government Stores Board, and on the conditions and quality of storage of goods. The Division has recently become the focal point in DSIR for work on effluent and waste disposal, the re-use of materials, dealing with spills of hazardous chemicals, and many facets of energy research.

In the last three years there has been a considerable build-up of chemical and mineral engineering staff and facilities, so that industrial chemical research can advance to the stage of pilot-plant scale operation and economic assessment. The establishment of a new Division of DSIR incorporating these chemical engineering and processing functions is envisaged over the next few years.

CHRISTCHURCH INDUSTRIAL DEVELOPMENT DIVISION

244 St Asaph Street, Christchurch
POSTAL ADDRESS: P.O. Box 1152, Christchurch
TELEGRAMS: RADEV Christchurch TELEPHONE: 62 369 Christchurch
DIRECTOR: T. H. Scott, BE Elec Mech, CEng, MIEE, MNZIE.

Standards Testing and Product Development: F. W. Seldon, BE, CEng, MIEE, MIMechE.
Electronics and Acoustics: E. D. Shipley, BSc.
Machine Development: A. A. J. Robertson, BE, AISE.
Liaison and Information: D. A. Hills, BSc, AIRI.
Materials Science and Metallurgy: G. L. Allen, BScEng *Calif.*
Electrical Engineering: B. J. Halpin, BE(Hons)Elec, MNZIE.
Industrial Engineering: B. Donohue, BE(Hons)Mech.
Instrumentation: S. J. Hough.

STAFF at 31-3-76: 11 scientists, 17 science technicians, and 12 supporting staff.

The Division provides South Island industry with a scientific research and development service, aimed at the fuller use of science by industry to develop products; to set and maintain higher standards of quality; and to reduce production costs. Thus, the Division assists with applied research, development, testing, consulting, and services not otherwise available to industry.

Current Projects

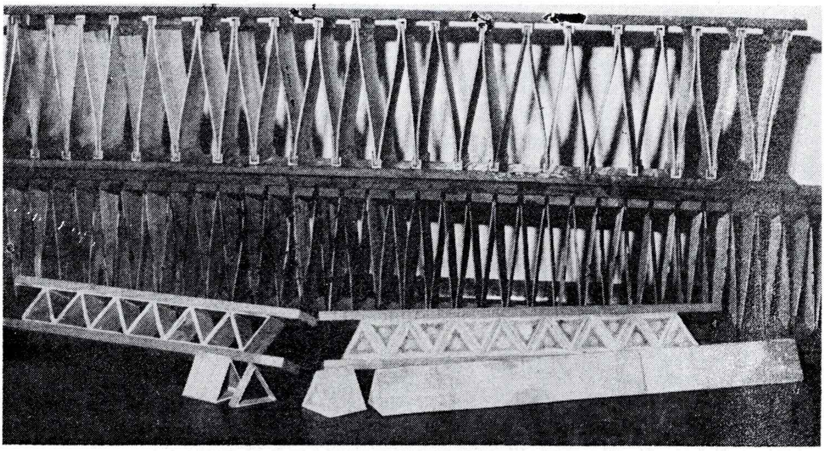
MATERIALS SCIENCE: wood enginering, including composite mouldings and use of beech; light-weight building panels; selective coatings for solar collectors and solar-energy district heating; evaluation of available basic refractories.

STANDARDS TESTING AND PRODUCT DEVELOPMENT: prototype development of a recently designed helmet for top-dressing pilots; Standards testing of industrial safety belts, safety helmets, and electrical appliances; assistance with the design of helmets and electrical appliances; assistance to manufacturers seeking export markets in Australia; use of missile-impact tester to evaluate safety products.

ELECTRICAL ENGINEERING: product development of insulators and fuses to meet Australian specifications; impulse tests on transformers; radio-interference testing; testing and design improvements on insulators, circuit breakers, fuses, transformers, and bus-bars; installing 3000-A test facility; planning 50 000-A test station.

ELECTRONICS AND ACOUSTICS: tracking device for chamois to monitor movements; development of industrial balancing equipment; consulting on community noise and assisting planning authorities and local bodies with acoustic measurements; metal detection in the meat and lime industries.

INSTRUMENTATION: calibration, manufacture, and repair of instruments; instrumentation of wind tunnel for forestry research; advising on instruments and their application; photographic work for the Division.



CIDD has been experimenting with laminated timber products, many using native beech. The photo shows several experimental lightweight beam constructions; the example at lower right is a triangular construction filled with rigid polyurethane foam.

INDUSTRIAL ENGINEERING: industrial measurements in thickness, weight, pressure, stress, temperature, hardness; air-flow characteristics; advice on machine alignment; dynamic balancing and vibration measurements for industry; manufacture of balancing equipment.

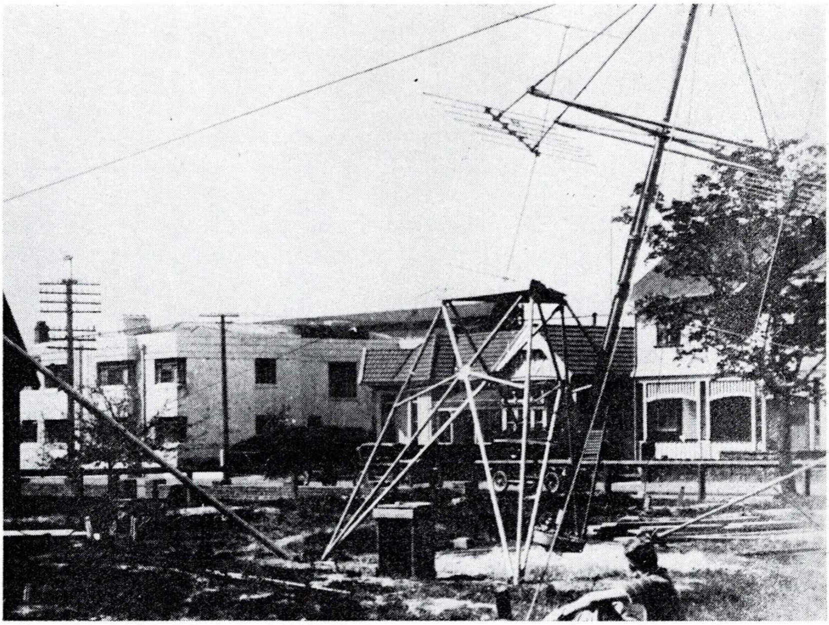
MACHINE DEVELOPMENT: extension of a pelt-removing-chain project for freezing works; controlled-environment wind tunnel to study plant growth; modification of a fish-tagging gun; design of a recompression chamber; assistance and advice on machine development in industry.

LIAISON: preparation of publications issued by the Division; arranging articles in outside journals; contact with news media; improving liaison with South Island industry; ensuring that every enquirer is put in touch with someone who can answer his question, give direct advice, or undertake the necessary testing or research.

HISTORY AND ACTIVITIES

During World War II DSIR set up several special research and development branches to carry out work for the armed services. One such unit was the Defence Development Section, concerned with radar development, which was established at Canterbury University College under the control of Mr T. R. Pollard, Senior Lecturer in electrical engineering. The College Council made available to DSIR various members of the College staff, as well as plant, apparatus and buildings. Over the war years a well-equipped research and development organisation gradually arose, integrating staff and assets of both the University and DSIR and in close contact with the Christchurch engineering industry.

At the end of the war it was thought desirable to retain at the College a small organisation to handle industrial research. After a conference of interested parties in 1947, the establishment of a College-controlled organisation was suggested to the College Council and DSIR.



A long-range air warning aerial being raised for a trial on the grounds of Canterbury University College during World War II by the Defence Development Section of DSIR. After the war a small organisation for service to industry was retained at the college; this developed into CIDD.

The recommendations were adopted, and the Canterbury University College Industrial Development Department (CCIDD) began work in October 1948, with Mr Pollard as Director. Most of the staff remaining with the Defence Development Section were transferred to CCIDD (later UCIDD after the change of the University's name).

CCIDD recovered some of its operating costs from work done for industry, University, and Government departments, the balance being made up in the form of a grant from the DSIR. In 1969 the Department was transferred to DSIR, becoming the present CIDD. The nature of the work undertaken by this Division is essentially the same as that assigned to CCIDD in 1948. Thousands of industrial jobs have been handled successfully; basic research projects include the construction of three radio ionosonde units, which formed a major part of New Zealand's contribution to the International Geophysical Year.

Good yields of solasodine, a suitable starting material for the preparation of contraceptive and anti-inflammatory drugs, have been got from two New Zealand native plants of the *Solanum* species. Crop Research Division has conducted many trials to establish the best growing conditions for these plants; the photo shows the harvesting of an experimental crop of *Solanum aviculare* in North Taranaki. Photo: Ivon Watkins-Dow Ltd

CROP RESEARCH DIVISION

Ellesmere Junction Road, Lincoln
POSTAL ADDRESS: Private Bag, Christchurch
TELEGRAMS: PLANTLAB Christchurch TELEPHONE: 8019 Halswell
DIRECTOR: H. C. Smith, PhD *Cantab*, FNZIAS.

Agrometeorology: J. W. Sturrock, DipAgr, PhD *Edin.*
Agronomy: D. J. G. Davies, DipAgr, DipAgrSc.
Cereals: G. M. Wright, MSc.
Crop Evaluation: A. D. Hall, BAgrSc, DipAgr.
Field Crops: T. P. Palmer, MAgrSc.
Fruit and Glasshouse: I. K. Lewis, PhD *Cant*, DipHortSc.
Genetics: P. A. Burnett, PhD *Mnb.*
Potato-Food Technology: A. S. Bedi, MAgrSc, PhD *Edin.*
Process Crops: J. Lammerink, IrAgr *Wagen.*
Seed: J. P. Malcolm, MAgrSc.
Vegetables: H. J. Giesen, IrAgr *Wagen.*

Lat.: 43° 38′ S. *Soil series:* Alluvial silt loams. *Rainfall:* 635 mm per annum on 125 days; distribution erratic, late spring droughts common. Mean evaporation (4 years), 955 mm per annum. *Temperature:* Mean maximum 16.1°C; mean minimum 6.8°C; mean 11.6°C. *Days of ground frost:* 93. *Hours of sunshine:* 2041.

SUBSTATIONS

OTARA: Crop Research Station, P.O. Box 61060. J. A. Palmer, BSc *Rdg.*
PALMERSTON NORTH: c/- Grasslands Division, Private Bag. J. M. McEwan, PhD *Mnb.*
GORE: Crop Research Station, Private Bag. D. S. C. Wright, PhD *McGill.*

STAFF at 31-3-76: 33 scientists, 36 science technicians, and 25 supporting staff.

The Division is responsible for breeding improved varieties of arable and horticultural crops to increase crop productivity, and conducts research in crop processing, food technology, genetics, plant breeding, and seed production.

Current Projects

FIELD CROPS: development of improved lucerne varieties: development of hybrid sweetcorn and maize varieties for different climates; breeding swedes for resistance to clubroot and rape for resistance to aphids; evaluation of new crop varieties in comparison with existing local and overseas varieties; maintenance of Breeders Seed of all Government-certified cultivars of wheat, barley, oats, peas, kale, rape, and turnips and distribution to growers through appointed agents.

INDUSTRIAL CROPS: breeding high-yielding, high-quality spring and autumn wheats; breeding high-yielding barley and oat varieties for processing and feed grain; breeding peas for processing and evaluating other legume crops; breeding rape, linseed, and sunflower varieties for oil; development of the peppermint crop for oil.

ENVIRONMENT: studies of shelter belts and crop reaction to wind; crop response to irrigation under different wind exposures; alteration of plant form and dry-matter distribution; weed control studies with high protein pulse crops including lupins and lentils; studies on the development of *Solanum* as a drug crop and its tolerance to herbicides; evaluation of cereals for winter forage production; evaluation of local and imported strains of tree nut crops for shelter, and timber and nut production; infra-red aerial photographic assessments of grass grub damage to pasture, stem nematode injury to lucerne, and extent of wind-blown timber from severe storms.

HORTICULTURAL CROPS: improvement of vegetable crops for processing and for fresh market, including methods of seed production for F_1 hybrid varieties; breeding potatoes for fresh market and for processing; evaluation of culinary herbs; breeding and selection of raspberries, strawberries, and apricots for improved flavour and increased yields.

GENETICS: screening lucerne cultivars for resistance to stem nematode; screening cereal cultivars for resistance to barley yellow dwarf virus, mildew, leaf rust, and aphids; ecology of aphid vectors in co-operation with Plant Diseases Division, Lincoln; evaluation of screening techniques for tolerance to *Verticillium* wilt in potatoes; evaluation of potato cultivars for resistance to potato cyst nematode and determination of yield loss due to potato cyst nematode.

HISTORY AND ACTIVITIES

Organised crop improvement in DSIR began in 1927 with the establishment of the Plant Research Station, Palmerston North, conducted in co-operation with the Department of Agriculture. Early successes were achieved in selecting for disease resistance, selecting pure lines of crop varieties, and producing nucleus seed for the new seed certification scheme devised by Mr J. W. Hadfield, in charge of the Agronomy Section at the Station.

Seed production has been concentrated at Lincoln since 1931, when the Government Pure Seed Station was established on 52 acres provided by Lincoln College. Over the last 45 years potato yields have been increased by selection of pure strains and reducing the level of virus infection. Smut diseases were eliminated from barley and wheat by developing a practical hot-water treating method and distributing adequate quantities of clean seed. Turnip variety names were standardised and seed free from dry rot disease developed. Methods were also devised to overcome club root disease in turnip and rape crops.

In 1936 the Plant Research Bureau was formed. It included the new Agronomy Division (sited at Lincoln and incorporating the Government Pure Seed Station) and assumed some of the functions of the defunct Plant Research Station. Further improvements were made in strains of lucerne, rape, and field and garden peas. Linen flax varieties introduced in 1936 were tested for field performance throughout the country; fibre, yield, and quality tests were made using pilot plants at Lincoln. By the outbreak of World War II it had been proven that linen flax could be successfully produced in New Zealand.

The German occupation of Europe deprived Great Britain and Ireland of their main supply of linen flax, so fibre production in New Zealand was rapidly increased. At the peak of war-time production 17 processing factories were in operation at various points in the South Island. Of the fibre produced, 88% was exported and the balance used locally. The seed was also harvested and mostly used for the manufacture of linseed oil.

Between 1936 and 1950 improved varieties of sweet blue lupins, rapes, kales, swedes, and peas were released for commercial growing.

In 1950 Agronomy Division amalgamated with the wheat-breeding section of Wheat Research Institute to form Crop Research Division (CRD), directed by Dr O. H. Frankel. Plant breeding activities were intensified and expanded to include a range of crops, and under the present Director, Dr H. C. Smith, new activities began in agrometeorology, food technology, and regional crop evaluation. Substations were established at Otara in 1951, Palmerston North in 1967, and Gore in 1971.

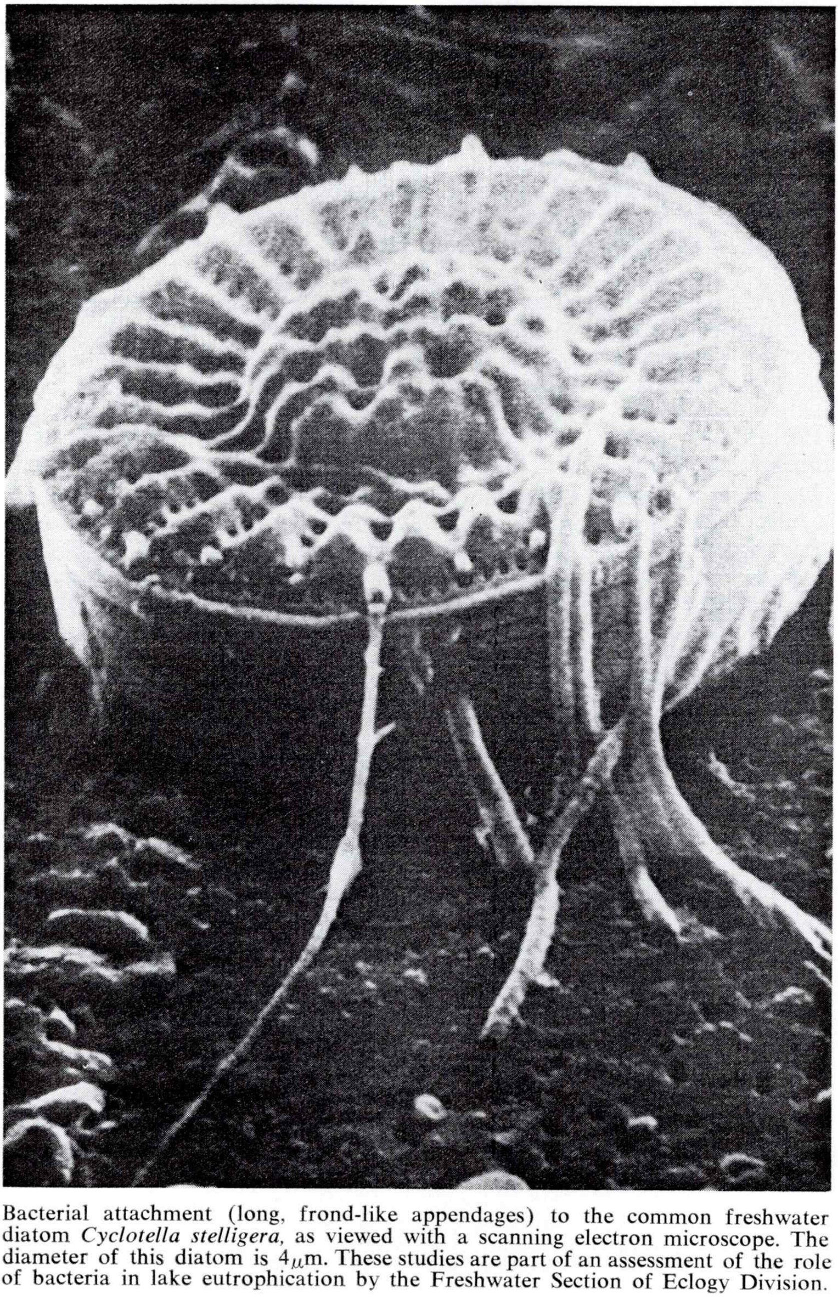
Outstanding improvements have been made in all the important agricultural crops grown in New Zealand. The wheat and oat industries now rely almost entirely on CRD-bred cultivars, which have significantly raised production and quality levels. The main autumn wheat cultivars today are 'Arawa' (released in 1955), 'Aotea' (1957), 'Hilgendorf' (1961), and 'Kopara' (1973). With these varieties disease and wind damage are reduced and milling and baking quality improved.

Turnips, swedes, Chou moellier, kale, and rape, taken as a group, is one of the largest crops in New Zealand, occupying about the same area as cereals. More stable and uniform CRD cultivars, incorporating disease- and pest-resistant factors, have given great production benefits. All brassica seed supplies are now produced locally whereas before World War II New Zealand was dependent on imported seed of cultivars which were not so well adapted.

The Potato Section of CRD has produced eight cultivars, of which 'Rua', released in 1959, is now one of the three main cultivars in New Zealand.

Peas are an important crop, for processing green and for the export of white splitting peas and blue peas. CRD has raised production by releasing disease-resistant processing and white pea cultivars.

Important contributions have also been made to improving horticultural crop cultivars, such as uniform lines of cabbage, cauliflower, and onions. The new CRD F_1 hybrid glasshouse tomatoes have been very well accepted, and excellent progress has been made in developing new process varieties of field tomatoes.



Bacterial attachment (long, frond-like appendages) to the common freshwater diatom *Cyclotella stelligera,* as viewed with a scanning electron microscope. The diameter of this diatom is 4$_{\mu}$m. These studies are part of an assessment of the role of bacteria in lake eutrophication by the Freshwater Section of Eclogy Division.

ECOLOGY DIVISION

Apex House, Laings Road, Lower Hutt
POSTAL ADDRESS: P.O. Box 30466, Lower Hutt
TELEGRAMS: ECOLOGY Lower Hutt TELEPHONE: 699-059 Wellington
DIRECTOR: J. A. Gibb, DPhil *Oxon.*

Biological Survey and Birds in Agriculture: P. C. Bull, DSc *Vic.*
Orongorongo Valley Field Station (forest ecology): R. E. Brockie, PhD *Vic.*
Beech Forests and Reserve Management: R. H. Taylor.
Freshwater Ecology: E. White, PhD *Durham.*

SUBSTATIONS

TAITA: *Laboratory*, Animal House, and Workshop, c/- Soil Bureau, R. E. Brockie, PhD *Vic.*

TAUPO: Freshwater Section, Ecology Division, P.O. Box 415. E. White, PhD *Durham.*

HAVELOCK NORTH: Bird Research Laboratory, DSIR Research Orchard, Goddards Lane. T. P. G. Purchas, PhD *Vic.*

NELSON: Ecology Division, Private Bag. R. H. Taylor.

STAFF at 31-3-76: 26 scientists, 21 science technicians, and 8 supporting staff.

The Division conducts research on factors affecting the distribution and numbers of birds, mammals, and other fauna; the effects of fauna on vegetation and in agriculture; and processes affecting the quality of freshwaters.

Emphasis is given to wildlife on agricultural land, including predation by starlings on pasture insects; to the role of birds and mammals in forest and other ecosystems not dominated by man, and to ecological surveys of areas of special scientific, economic, or aesthetic importance, including off-shore and subantarctic islands. Increasing research concerns the enrichment of freshwaters by nutrients from towns and farms.

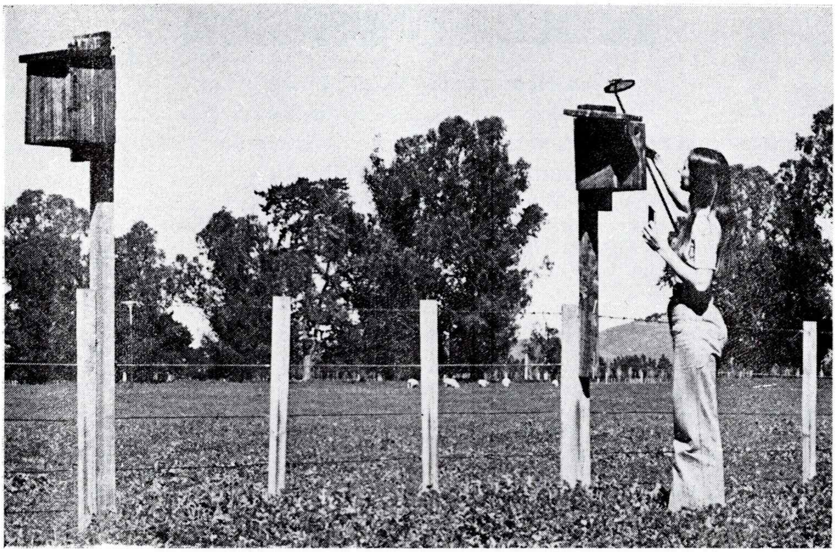
Though the Division is not responsible for the control of noxious animals or the conservation of wildlife, nor for land or freshwater management, its scientists are involved in the relevant research. The Division advises on a wide range of environmental problems and assists with the auditing of environmental impact reports.

Current Projects

BIOLOGICAL SURVEY: mapping the New Zealand distribution of birds, lizards, frogs, bats and other fauna; surveys of off-shore islands, with emphasis on birds, mammals, and lizards; effects of browsing mammals on the vegetation, and of carnivorous mammals and rodents on native fauna; biology of stoats in National Parks.

BIRDS ON AGRICULTURAL LAND: biology and control of rooks in Hawke's Bay; evaluation of bird damage to crops and methods of alleviating it; population biology of starlings and their role as predators on pasture insects.

ECOLOGY OF NATIVE FORESTS: *Orongorongo Valley Field Station* – studies of vegetational changes emphasising the effects of browsing mammals; phenology of trees and shubs; litter-fall and seed production; effects of variations in seed production on rodent numbers; ecology of



Ecology Division is studying starling predation on grass grubs in Hawke's Bay. Nestboxes are provided and are here shown being inspected with a mirror to assess the reproductive success of the birds.

feral cats and stoats; biology of feral goats; population ecology, food, nutrition, and activity of opossums; defoliation of rata by opossums and insects; ecology of litter invertebrates; collection of Lepidoptera; population ecology and foods of native birds. *Nelson Substation* – numbers, movements, and hunting pressure on red deer in Nelson Lakes district; effects of beech forest management on birds and mammals; methods of counting birds in forests; bird numbers related to habitat, food supply, and predators; requirements for biological reserves.

FRESHWATER RESEARCH: studies of the general limnology of Lake Taupo and of nutrient contributions from its catchment; identification of nutrients limiting plant growth; phenology of the algal flora; zooplankton and benthic fauna; nutrient flux in groundwaters; movement of nutrients from septic tanks, study of the consequences for water management of diversions of the Tongariro Power Development to Lakes Rotoaira and Taupo, with emphasis on the effects of adding biologically available manganese to Lake Taupo; nutrient limitation to plant growth in Lake Rotorua; the role of lake sediments as nutrient sources; examination of the Kaituna River as a possible recipient of treated sewage effluent from Lake Rotorua; monitoring the nutrient status of the Arrow River in connection with its possible use to flush Lake Hayes.

HISTORY AND ACTIVITIES

In 1948 a Wildlife Section was formed at DSIR Head Office, as a result of a survey of the economic status and control of introduced mammals completed by Dr K. Wodzicki in 1947. The initial survey was limited to animals of particular economic importance, but the committee considering the report recommended further study and the inclusion of all introduced mammals. The Wildlife Section was formed to do this, with Dr Wodzicki as Officer-in-Charge and a staff of two. (The Section's name was soon changed to Animal Ecology Section to prevent confusion with the Wildlife Branch of the Department of Internal Affairs.) Published in 1950, the final report of the extended survey is Dr Wodzicki's well-known *Introduced Mammals of New Zealand* (DSIR Bulletin 98).

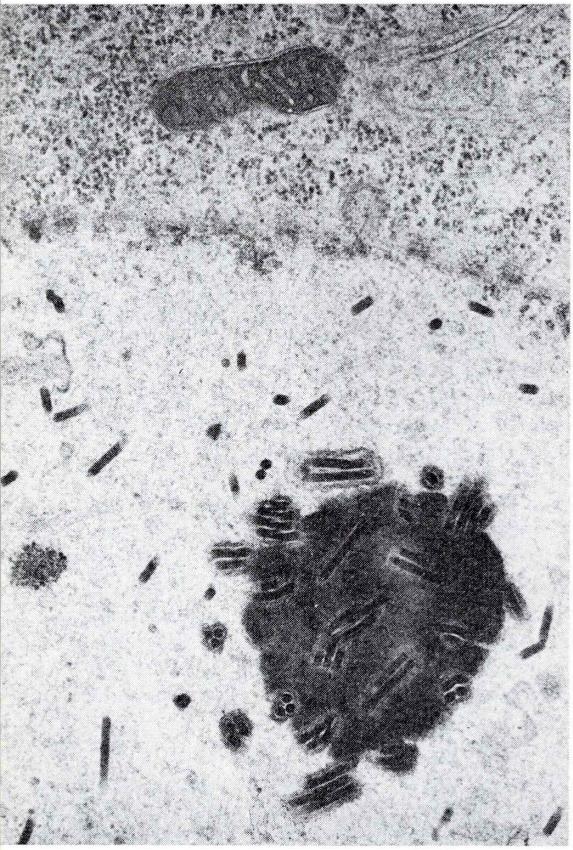
By 1950 the Section had already begun research on the ecology of rabbits which was to be its main concern for the next 10 years. The present Head Office of DSIR in the Charles Fergusson Building, Bowen Street, Wellington, stands close to the site where lie buried the remains of more than 12 000 rabbits autopsied between 1950 and 1960 in a small shed behind the earlier Head Office building.

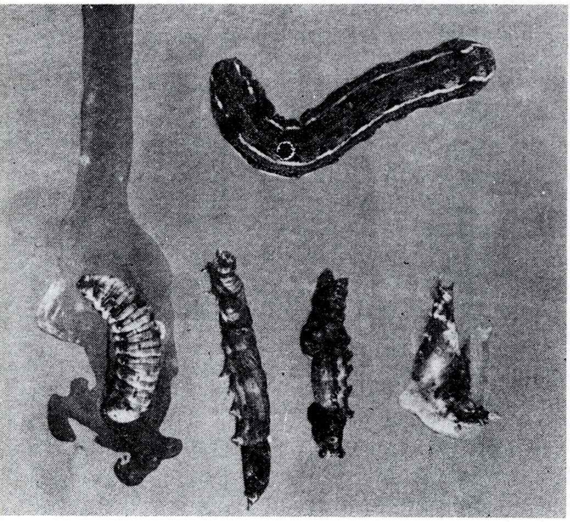
Animal Ecology Division was formed in 1960, with Dr Wodzicki as Director and a staff of 10. The Division moved to its present quarters in Lower Hutt, which were shared for a few years with animal research scientists of the Forest Research Institute. In 1962 the Division collaborated with the Forest Service in a study of deer, chamois, and hares in Nelson Lakes National Park. To allow studies of bird damage to crops, a small substation was opened in 1965 at the DSIR Research Orchard in Havelock North. This Station still thrives, though the emphasis of research there shifted first to the ecology and control of rooks, and then to the role of starlings as predators of pasture insects. By the time Dr Wodzicki retired in 1965, the Division had a staff of 18 and had developed wide interests in animal ecology throughout New Zealand and on the outlying islands south to Antarctica.

In 1966 the Division took over the Forest Service base in the Orongorongo Valley, near Wellington, which has since become a field station for research in many aspects of forest ecology, especially forest mammals; about 16 scientists and science technicians are now working there. Forest research was extended when the Forest Service planned to use beech forests in Nelson and north Westland, and in 1974 DSIR set up a small beech forest research group in Nelson which includes 5 members of Ecology Division.

The Freshwater Section of Ecology Division was established in 1969-70 to study the causes and effects of eutrophication. (The word "Animal" was consequently dropped from the Division's name.) Initially, the Section was based with Soil Bureau at Taita, Hutt Valley, but it transferred to Taupo in 1974. Lake Taupo was chosen as the site for DSIR freshwater research because of its importance to hydroelectric power generation, for its fishery and recreational values, and because the extensive development of its land catchment threatens the water quality of the lake and hence of the Waikato River. The Freshwater Section staff should number about 25 by 1977.

Because demands for ecological research on the natural environment are increasing rapidly, Ecology Division will continue to grow and it will probably become even more involved with practical problems arising directly or indirectly from man's growing pressure on the environment. However, it will also be necessary to strengthen basic research on which all sound management of natural resources is founded.





Entomology Division is investigating the structure and composition of baculoviruses of pasture pests by electron microscopy. Upper photo is an electron micrograph of virus particles from the tropical army caterpillar *(Spodoptera litura).*

Lower photo shows one healthy fully grown tropical army caterpillar (top) and four which have died 7 days after being infected with virus. The caterpillar at lower left is surrounded by exudate containing the virus; this is one way in nature by which the virus is spread to other caterpillars.

ENTOMOLOGY DIVISION

120 Mount Albert Road, Auckland 3

POSTAL ADDRESS: Entomology Division, DSIR, Mt Albert Research Centre, Private Bag, Auckland

TELEGRAMS: ENTLAB Auckland TELEPHONE: 861 059 Auckland

DIRECTOR: J. M. Hoy, DSc *Cantab.*

Biological Control: E. W. Valentine, BAgrSc, DIC.
Ecology: C. H. Wearing, PhD *Lond*, DIC.
Nematology (joint section with Plant Diseases Division): F. H. Wood, PhD *Cantab.*
Physiology: O. R. W. Sutherland, PhD *Cantab.*
Rearing: P. Singh, Assoc IARI, PhD *New Delhi.*
Systematics: J. C. Watt, D Phil *Oxon.*
Virology: J. F. Longworth, MSc.

SITE AND CLIMATE

Lat.: 36° 54′ S. *Long.:* 174° 44′ E. *Area:* 12.5 ha. *Soil type:* Basalt from volcanic cone of Mount Albert, overlying argillaceous sandstone; where sandstone is exposed, the soil is podzolised. *Rainfall:* Average 1356 mm per annum on 143 days, almost evenly distributed throughout the year, greatest from May to August and least from November to March. *Temperature:* Mean maximum 19°C; mean minimum 11°C; mean 14.5°C. *Days with ground frost:* 17. *Hours of sunshine:* 2102 (Albert Park).

SUBSTATIONS

LINCOLN: c/- Crop Research Division. A. D. Lowe, MAgrSc.

PALMERSTON NORTH: c/- Grasslands Division. M. J. Esson, BSc.

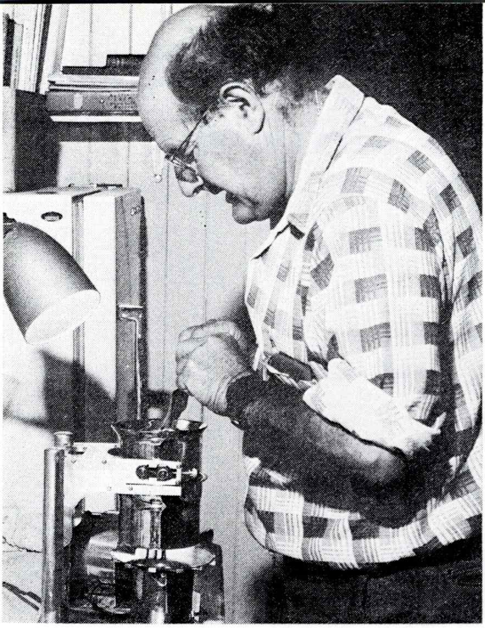
STAFF at 31-3-76: 38 scientists, 37 science technicians, and 10 supporting staff.

The Division conducts research on insects, mites, and plant nematodes, with emphasis on those species of economic importance in agriculture and horticulture. Research is oriented towards the development of control methods involving minimum use of toxic chemicals and the exploitation of beneficial species.

Current Projects

BIOLOGICAL CONTROL: introduction of parasites of noctuid caterpillars, e.g., cosmopolitan and tropical army caterpillars, cutworms, budworms; preliminary investigations into the possibilities of applied biological control of black beetle; biological control of nodding and creeping thistles by introduction of phytophagous insects; introduction and establishment of insecticide-resistant predaceous mites; introduction and establishment of leafcutter and alkali bees for legume pollination and pumpkin bees for cucurbit pollination; studies on the behaviour and ecology of bumble bees as pollinators; systematic studies on parasitic Hymenoptera associated with applied biological control projects; surveys for predator and parasite establishment.

ECOLOGY: *pasture* – resistance of pasture plants to grass grub, porina, Tasmanian grass grub, and Argentine stem weevil; resistance of legumes to clover case bearer; effects of farm management on porina; effects of physical environment on growth and survival of grass grub; energetics of a grass grub–pasture system; seasonal changes in abundance of



Surveys of commercial apple orchards in Nelson by Entomology Division have shown that a strain of *Typhlodromus pyri* (a predator of the apple pest European red mite) is resistant to the insecticide, azinophos-methyl. The insecticide continues to control insect pests without endangering predators of mites, and reduces the need for costly miticides.

Central to the survey, which is being extended to Hawke's Bay and Marlborough, is the collecting of mites and predators from apple leaves by machine-brushing, as shown in photo.

pasture fauna in hill country; ecology of clover case bearer; life cycle and distribution of flores weevil and other weevils attacking legumes; dispersal and physical ecology of white fringed weevil; effects of insecticides and fungicides on earthworms; insecticides for control of black beetle. *Field crops* – ecology of crop aphids; parthenogenesis in aphids; monitoring pest resistance to pesticides, e.g., mealy bug, whitefly, European red mite. *Vegetables* – ecology of brassica pests; insecticides for control of brassica pests and seed corn maggot; cultural control of potato tuber moth. *Fruit* – integrated control of apple pests; ecology and control of codling moth and San Jose scale; insect population monitoring using pheromones; ecology and control of greedy scale and leafrollers on chinese gooseberry; nationwide survey of species composition of leafroller populations; fumigation of strawberry plants for 2-spotted mite control; comparison of susceptibility of leafroller species to insecticides. *Taxonomy* – aphids, pygmephorid mites.

NEMATOLOGY (joint programme with Plant Diseases Division): dissemination, spread, and chemical control of stem eelworm in lucerne; chemical control of root-knot nematode in clover and lucerne; screening white clover and lucerne varieties for resistance to nematodes; interaction between root-knot nematode and nodulation in white clover; role of nematodes in the "pasture decline" syndrome; life history, genetics, pathotype definition, population dynamics, yield effects, and control of potato cyst nematode; control of root-knot nematodes in carrots; role of dagger nematode in decline of apricots; role of lesion nematode in decline of apples and cherries; influence of environmental factors on nematodes biology; microanalysis of nematodes; nematode diseases of crops in the Cook Islands; insect-parasitic nematodes as potential biological control agents; taxonomy of cyst-forming nematodes.

PHYSIOLOGY: analysis of the behaviour of pasture and crop pests with emphasis on the role of chemical attractants, repellants, feeding stimulants, and deterrents; isolation and identification of chemical factors involved in pasture plant resistance to grass grub and black bettle; chemistry and biological role of insect defence secretions; chemistry of pheromones of horticultural pests and use of these in survey and control programmes; location, structure, and function of insect chemoreceptors; electrophysiology of behavioural responses of grass grub, codling moth, and leafrollers.

REARING: development of artificial diets and mass-production for economically important insects; studies of basic nutritional physiology, nutritional diseases, gnotoentomology, and symbiont association with micro-organisms; role of antibiotics, antimicrobial food additives, and antimetabolites in diets; hormonal physiology and investigations into entomologically active compounds from plants and their synthetic analogues (jointly with Applied Biochemistry Division); development of methods for shipping and transporting insects.

SYSTEMATICS: survey, identification, classification, and characterisation of the New Zealand terrestrial and freshwater arthropod fauna; biological studies; association of immature stages with adults; life histories; evolution; relationships with host plants; ectoparasites; insular faunas including Kermadecs and subantarctic islands; biogeography; comparative faunal surveys; conservation; epigean and phreatic faunas; arthropods of Cook Islands, Niue, Tonga, and Samoa.

VIROLOGY: basic studies on structure and composition of baculoviruses of light brown apple moth, codling moth, potato tuber moth, and tropical army caterpillar; investigations of the efficacy of the baculovirus of light brown apple moth in field control; characterisation of a picornavirus of black beetle, its distribution and role as a natural regulatory factor in field populations; similar ecological studies on the role of a protozoan *Adelina* sp. in the regulation of black beetle populations; search for and evaluation of virus diseases of pasture insects, including grass grub, porina, and armyworm.

HISTORY AND ACTIVITIES

As with several Agriculture and Biology Divisions of DSIR, Entomology Division was formed in 1937 when the Plant Research Bureau was transferred to DSIR from the then Department of Agriculture. The Division worked mainly on crop and pasture entomology, and Plant Diseases Division, in Auckland, carried out some research in horticultural entomology.

Entomology Division was first established at Nelson, where a fairly strong entomological section already existed at the Cawthron Institute. Dr David Miller, the Cawthron's chief entomologist, became the Division's first director. In 1948 Entomology Division and the Cawthron Institute section amalgamated to form the Entomological Research Station, but, after Dr Miller was appointed Director of the Cawthron Institute in 1956, Entomology Division was re-established. It assumed responsibility for all DSIR entomology, and therefore strengthened its work on horticultural entomology, particularly on fruit pests.

As part of DSIR's policy to establish centres with common research themes, it was decided in the 1960s to move Entomology Division from

Nelson to Auckland where it could, with Plant Diseases Division, provide a national centre for plant protection research. This transfer was made in 1973 on completion of the Hamilton Building at Mt Albert Research Centre. The Division retained its substation at Palmerston North and that at Lincoln was considerably strengthened. Strong collaborative research relationships have developed between Entomology and Plant Diseases Divisions, and a joint nematology section has been formed.

Research undertaken by Entomology Division in the 39 years since its establishment can be broadly divided into three periods.

From 1937 to the late 1940s research work concentrated on the development of methods of biological control for important pests of field crops and attempts to find methods for controlling pasture insects involving the use of parasites, predators, and the then available insecticides such as Paris green and lead arsenate.

Between 1950 and 1965, as a range of persistent organochlorine insecticides (such as DDT, lindane, and dieldrin) became available, research was oriented to development of chemical controls for pasture and field-crop insects. The use of these persistent insecticides changed the pattern of farming in New Zealand and allowed, for the first time, the maintenance of the relatively permanent pastures on which much of our present agricultural economy is based.

The 1960s saw an increasing awareness of the problems associated with environmental contamination by persistent insecticides and the growing occurrence of insect resistance to insecticides. The Entomology Division research programme was considerably expanded to develop methods of insect control involving the minimum use of toxic chemicals. Thus, in present research programmes the major emphasis is on integrated control procedures combining the use of beneficial organisms, including parasites, predators, and pathogens; the development of cultural techniques for control; and the examination of plant resistance to insect attack.

That nematodes also pose serious problems in agriculture has been underlined by the recent detection of cereal cyst and potato cyst nematodes in New Zealand. The presence of the latter has had profound effects on the potato-growing industry as a whole and must lead to an increase in nematological research. There is also a need to strengthen essential back-up services to agricultural entomology such as insect rearing, insect physiology, and associated organic chemistry. At present, about 50% of the staff are engaged in research concerned with pasture pests and 25% each with pests of horticulture and field crops.

The Division's primary responsibility is to develop methods of agricultural pest control, but it is also responsible for the identification and classification of New Zealand insects, mites, and nematodes. Continuing efforts have been made to enlarge the Systematics Section, both for this task and to provide an identification service. The complexity of the work is indicated by its size – it is estimated that New Zealand has more than 20 000 species of endemic insects. In addition, the Systematics Section has become increasingly involved in insect surveys for neighbouring Pacific island countries.

GEOLOGICAL SURVEY

State Fire Building, Andrews Avenue, Lower Hutt
POSTAL ADDRESS: P.O. Box 30368, Lower Hutt
TELEGRAMS: GEOLOGICAL Lower Hutt TELEPHONE: 699 059 Wellington
DIRECTOR: R. P. Suggate, MA *Oxon,* DSc *NZ,* FRSNZ.

Project Geology: G. W. Grindley, DSc *Otago,* FRSNZ.
Paleontology: C. A. Fleming, O.B.E., DSc *NZ,* FRS, FRSNZ; G. R. Stevens, PhD *Cantab.*
Micropaleontology: N. de B. Hornibrook, DSc *Vic,* FRSNZ.
Petrology: W. A. Watters, PhD *Cantab.*
Engineering Geology: L. E. Oborn, AOSM.
Economic Geology: B. N. Thompson, MSc.
Technical Liaison and Information: S. N. Beatus.

DISTRICT OFFICES

AUCKLAND: Otara Research Station, Otara Road, Papatoetoe. P.O. Box 61012, Otara. Telephone: 49 529 Papatoetoe. J. C. Schofield, MSc.

HUNTLY: P.O. Box 18. A. M. Sherwood, MPhil.

ROTORUA: NZBC Building. P.O. Box 499. Telephone: 82 189 Rotorua. I. A. Nairn, MSc.

TURANGI: c/- Ministry of Works, Private Bag. Telephone: 7799 Turangi. B. R. Paterson, BSc.

NELSON: Milton Street. Private Bag. Telephone: 81 082, 82 319 Nelson. M. R. Johnston, PhD *Vic.*

GREYMOUTH: Custom Street. P.O. Box 90. Telephone 7569 Greymouth. W. A. Sara.

CHRISTCHURCH: Geology Building, University of Canterbury. Private Bag. Telephone: 71 649 Christchurch. G. Warren, MSc.
Sedimentation Laboratory: Location and address as Christchurch District Office. P. B. Andrews, PhD *Texas.*

TWIZEL: c/- Ministry of Works. Private Bag. Telephone: 809 Twizel. S. A. L. Read, BSc (Hons).

CROMWELL: Melmore Terrace, P.O. Box 64. Telephone: 423 (ext. 77) Cromwell. R. Thomson, BE (Mining).

DUNEDIN: P.O. Building, Moray Place. P.O. Box 5342. Telephone 77 722 Dunedin. I. C. McKellar, MSc.

STAFF at 31-3-76: 74 scientists, 36 science technicians, and 23 supporting staff.

Geological Survey works in all major fields of basic geology. Because there are few geological consultants in New Zealand, economic geology comprises about 50% of the Survey's work. It acts as geological consultant to all Government departments (but principally Works, Mines, Electricity, and Railways), to local authorities, and to many private companies and individuals.

The Survey issues geological maps, reports, bulletins, and scientific papers. These, with the extensive collections of rocks, minerals, and fossils in Lower Hutt, form an invaluable store of knowledge about the geology and mineral resources of New Zealand. In recent years the Survey has extended its explorations to Pacific Island Territories and Antarctica, and has become responsible for housing a complete air-photo library of New Zealand.

Current Projects

(A fuller list of current activities is given in: "DSIR Research 1975", *N.Z. DSIR Information Series 109*. 1975.)

REGIONAL GEOLOGY: assisting production of *The Geology of New Zealand,* recording 100 years of geological observation; continuing regional mapping of surface formations at 1:63 360 and the introduction of mapping on the new metric grid at 1:50 000, mainly in Nelson, Central Otago, Northland, South Auckland, Coromandel, and Wellington regions; larger-scale mapping (1:25 000) of city areas in Auckland and Nelson and of the geology and waterwell data of areas around Christchurch and Blenheim.

PALEONTOLOGY: studies of fossiliferous Pliocene limestones in Hawke's Bay and Cretaceous rocks in the Gisborne district in relation to petroleum potential; studies of microscopic fossils in drill cuttings and cores to aid exploration for oil, gas, and coal; computerisation of records of fossils from all parts of New Zealand.

PETROLOGY: studies of the mineral content and weathering of greywacke-type sedimentary rocks; study of geologically recent, hydrothermally altered rocks and associated minerals in connection with geothermal investigations, both in New Zealand and overseas; studies of ore minerals associated with fossil hydrothermal systems, as at Coromandel Peninsula; research on lava and ash from active volcanoes in New Zealand as part of DSIR study of eruptive mechanisms and volcanic prediction; study of transport and deposition of sediments on beaches, in rivers, and in dune areas, with special reference to erosion, river control, and accumulation of economic minerals.

ECONOMIC GEOLOGY: Regional geological mapping of mineralised areas in Coromandel, north-west Nelson, Westland, and Otago; detailed studies of underground water resources (principally Northland, and Wairau and Canterbury Plains); coal resource studies (Huntly, Mataura); petroleum studies; assistance to countries of the south-west Pacific in petroleum and non-metallic mineral exploration; advice on regional and district planning schemes.

ENGINEERING GEOLOGY: studies of the geology, stability, and raw material requirements for dams, powerhouses, canals, tunnels, highways, subways, bridges, ports, building sites, and town planning; earthquake microzoning studies showing the relations between the geology of parts of cities and the response of buildings to earthquakes; maps of city areas showing the engineering characteristics of rock formations.

EARTH DEFORMATION STUDIES: mapping of late Quaternary tectonics (the record of past earth deformation associated with earthquakes), especially as applied to town planning and district schemes; participation in a UNESCO Earthquake Reconnaissance Mission, to study in the field the North West Frontier (Pakistan) earthquake of 1974; extending the fault monitoring network in New Zealand and applying tilt levelling methods to Broadlands Geothermal Field (normal deformation rates are being assessed in order to detect any rapid phenomena precursory to earthquakes).

ENVIRONMENTAL GEOLOGY: supplying information and advice to Government departments, local authorities and boards, mining and other development companies, etc., on the geological aspects of proposals requiring environmental impact reports; commenting as requested by the Commission for the Environment on completed impact reports submitted for audit.

SPECIAL PROJECTS: geological mapping in Antarctica (e.g., Cambrian rocks and paleontology of North Victoria Land, as part of an International Geological Correlation Programme); compilation of a tectonic map depicting the structural development of New Zealand and the surrounding oceanic shelf during the last 25 million years.

HISTORY AND ACTIVITIES

The Geological Survey, founded in 1865 with James Hector as Director, is one of the oldest scientific institutions in the country; only the Meteorological Service is of earlier origin. Between 1865 and 1926 the Survey showed only a gradual growth and diversification. However, since 1926, when it became one of the "foundation members" of DSIR, there have been many radical advances.

Modern electronic instruments now supplement the hammers and microscopes of earlier days. When accurate, detailed topographical base-maps and aerial photographs became available from the Department of Lands and Survey, Geological Survey could dispense with its topographers, and the field geologists could concentrate on geology instead of spending time on pace and compass traverses. Specialisation began and increased rapidly. A paleontologist (fossil expert) joined the Survey in 1911, becoming the first full-time Government paleontologist in the Commonwealth, and a petrologist (expert in rocks and minerals) was appointed in 1938. Paleontology and petrology are still the largest special sections; other specialists include geochemists and economic, engineering, and petroleum geologists.

Until 1939 all officers were based in Wellington. In 1905 Bell (the then Director) instituted the custom of establishing large field camps for the survey of considerable areas, called subdivisions. Fieldwork was done mainly in the summer from these bases, temporary "fly camps" being established where necessary, and officers returned to Wellington for the winter.

The first permanent field office was established in Greymouth in 1939 for surveys of the West Coast coalfields. Accommodation problems during World War II led to the establishment of district offices in Invercargill and Whangarei; just after the war the system was extended to several other provincial towns. Many district offices have been relocated, but the system, because of its many advantages, is being continued and extended.

Though there have been changes in emphasis, the basic functions of Geological Survey remain much the same. Its primary objective is to produce geological maps of New Zealand on various scales for different purposes and keep them up-to-date as new techniques of geological investigation arise and as geological knowledge increases. These maps serve as a starting point for many types of further investigations such as the search for workable mineral resources; the surveys required for the safe construction of large engineering works; and forecasting the effects on the environment of developments such as roading, drainage, irrigation, land reclamation, and flood control and power schemes, the construction of pipelines, and housing subdivisions.

Other functions of Geological Survey include the study of geological processes in New Zealand to determine how they affect our lives and buildings. Phenomena such as earthquakes, volcanic eruptions, river and coastal erosion, landslides ,and the growth and decay of glaciers occur with various degrees of predictability and control, depending largely on the extent of our knowledge of their causes.

Basic research on various aspects of earth science is undertaken, partly to increase scientific knowledge and partly in the hope (often justified by experience) that such new knowledge may be put to practical use. For example, the study of minute fossil shells has proved most useful in the exploration for oil and gas beneath the sea floors around New Zealand.

Nearly half of New Zealand has now been geologically mapped on a scale of 1:63 360 (1 inch to 1 mile). Also, between 1959 and 1968 a comprehensive geological map of the whole country was completed in 27 sheets on a scale of 1:250 000 (about 4 miles to the inch). Publication of these maps has, for example, provided a great stimulus to mineral and petroleum exploration.

Petrologists and paleontologists of the Survey have played important parts in the discovery and description of new types of minerals, rocks, and fossils. Some years ago the present chief Paleontologist, Dr C. A. Fleming, was elected F.R.S. (Fellow of the Royal Society of London) – a rare distinction – for his work in paleontology and the geological history of New Zealand.

The world standing of Survey geologists who have studied volcanoes and recent earth movements due to earthquakes has been recognised by the United Nations and other international bodies, which have sought their services to investigate these phenomena in developing countries throughout the world. Similarly, Survey officers have investigated and advised on the exploitation of geothermal energy in the Pacific, south-east Asia, Africa, and South and Central America.

GEOPHYSICS DIVISION

Observatory Reserve, Salamanca Road, Wellington
POSTAL ADDRESS: P.O. Box 1320, Wellington
TELEGRAMS: GEOPHYSICS Wellington TELEPHONE: 738 208 Wellington
DIRECTOR: T. Hatherton, O.B.E., DSc *Lond,* PhD Lond, DIC, FRSNZ.

SECTIONS AND OBSERVATORIES

DRILLING SECTION: Geophysics Laboratory, Gracefield Road, Lower Hutt.
Officer in Charge: J. E. Hoffman.

GEOPHYSICAL SURVEY: Geophysics Office, Observatory Reserve, Kelburn.
Superintendent: W. I. Reilly, BA, DSc, AOSM.
Geophysics Laboratory: Gracefield Road, Lower Hutt.
Officer in Charge: R. G. Jenkins.
Geothermal Laboratory: c/- Ministry of Works, Taupo.
Officer in Charge: G. E. K. Thompson, MSc.

SEISMOLOGICAL OBSERVATORY: Geophysics Office, Observatory Reserve, Kelburn.
Superintendent: R. D. Adams, MA, PhD *Cantab.*

APIA OBSERVATORY: Apia, Western Samoa.
Superintendent: P. D. Müller, BSc.

RAROTONGA OBSERVATORY: Rarotonga, Cook Islands.
Officer in Charge: G. K. Sorrell, NZCE.

STAFF at 31-3-76: 31 scientists, 33 technicians, and 8 supporting staff.

Geophysics Division activities cover not only New Zealand, but also a large area of the South Pacific extending from Samoa to Antarctica.

The Division, through its Geophysical Survey, investigates the types and structures of subsurface rocks. Such knowledge is required at engineering sites, for mineral and geothermal exploration, and for improving basic understanding of conditions and processes deeper in the Earth. The Drilling Section provides direct information about rocks, temperatures, or water conditions at depth.

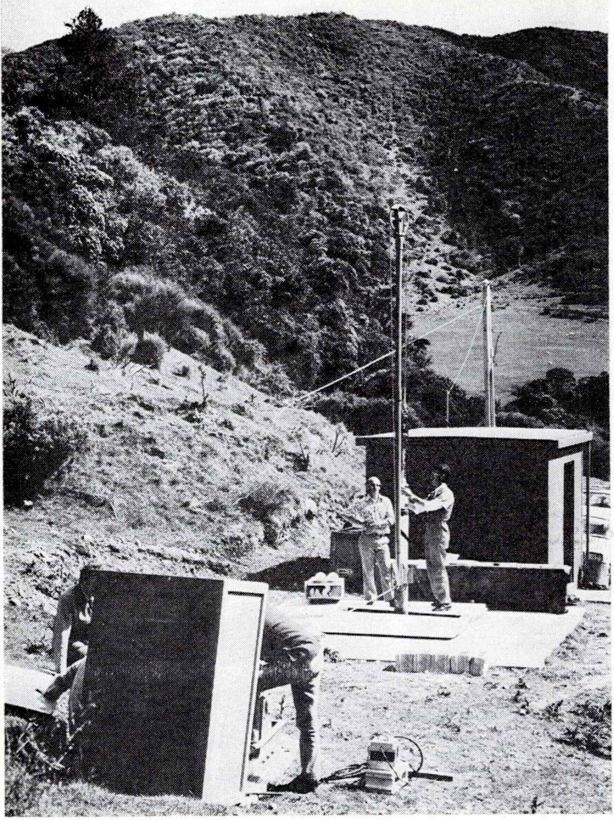
Through its Seismological Observatory the Division studies earthquakes and their distribution and effects in New Zealand. The Observatory contributes readings to international organisations for global analysis, and its Pacific Island stations from part of the Pacific-wide system for tidal-wave warnings. The Observatory also controls New Zealand Standard Time and disseminates it by radio and wire links.

Current Projects

SEISMOLOGY: study of seismicity around Lake Pukaki to determine effects due to impounding; development of radio-linked seismograph network for Wellington; installation of joint USA–NZ Seismic Research Observatory in south Karori, Wellington; testing of dilatancy theory of earthquake occurrence; study of earthquake mechanisms.

GEOPHYSICAL SURVEY: testing of audio-magneto-telluric method of electrical prospecting; deep electrical soundings in central volcanic region; exploration of Canterbury water resources; interpretation of aeromagnetic survey offshore from western North Island; development of down-hole bore log device.

DRILLING: production and monitoring wells for water in Tonga; aquifer studies in Nelson; Dry Valley drilling project, Antarctica.



Geophysics Division staff installing sensitive seismic detectors down a 100 m hole in South Karori, Wellington. Signals from the instruments are transmitted by land-line to the Seismological Observatory. Besides assisting in the study of local earthquakes, the detectors will improve the detection of underground nuclear explosions.

HISTORY AND ACTIVITIES

Formed in 1951, Geophysics Division is a combination of several small independent units: the Geophysical Survey; the Drilling Section; the Apia and Rarotonga Observatories; and the Seismological Observatory, which includes the NZ Time Service.

New Zealand Time Service

The oldest unit within Geophysics Division is the present New Zealand Time Service, which stems from the Colonial Observatory set up in the 1860s to provide an accessible source of local time sufficiently accurate for civil and navigational purposes.

With the advent of radio time signals the necessity for astronomical observations became less critical, and during the 1920s the developing science of seismology became the major observatory activity. As a result the Colonial Observatory, having changed its name to the Hector Observatory and then the Dominion Observatory, finally became the Seismological Observatory, of which the New Zealand Time Service is now part. The "time pips" supplied to the broadcasting system are probably the most widely used service provided by DSIR.

Seismological Observatory

Although the first instrumental recording of earthquakes in New Zealand dates from 1901, until the 1929 Murchison and 1931 Hawke's Bay earthquakes, there were only two horizontal pendulums in New Zealand.

Since then there has been a great, though at times fitful, improvement in instrumentation, and the Seismological Observatory now operates 30 stations in New Zealand and seven in the rest of the South-west Pacific from Western Samoa to Antarctica.

The Observatory routinely locates all earthquakes within 10° of Wellington which are of magnitude 4 or more, and those smaller shocks which are reported felt or are in areas of particular interest. In recent years about 700 shocks have been located annually, of which about half are of magnitude 4 or greater. Instrumental records are supplemented by reports from about 400 voluntary observers spread throughout the country, who complete a standard questionnaire whenever they feel an earthquake. Thus, the main features of New Zealand's seismicity are now well documented. Activity is divided into two principal regions, although the rest of the country is not earthquake-free. One region covers all the North Island (except the Northland Peninsula) and the northern part of the South Island, the other is confined to the Fiordland area.

Recent research interests throughout the world have included the possibility of earthquake prediction. At present most of the work in the Division and at Victoria University of Wellington is retrospective, i.e., attempting to predict known earthquakes on the basis of the data available before them. "Real-time" prediction will only be possible with a greater density of instrumental observation points, and a high density net is at present being installed around Wellington. Successful predictions made overseas, and they are very few, have occurred only in favourable circumstances. Nevertheless there is some confidence among geophysicists that, for the first time, a reasonable physical explanation of the earthquake mechanism is available for testing.

Geophysical Survey

The science of geophysics arose in the 1920s when it became possible to use physical observations made at the surface of the earth to study rocks below the surface, thus adding another dimension to geological investigations. Geophysical Survey's formation (within the N.Z. Geological Survey) coincided with the depression of the 1930s, so work was initially concerned with the exploration of alluvial gold prospects in the South Island. The development of the Waikato River for hydro-electricity production saw the inauguration of a programme of geophysical investigations of dam sites which proved so successful that, to date, 81 separate surveys have been made at the request of power-planning authorities. In 1949, as the Waikato River surveys ended, a study of the geothermal system at Wairaki began. Divisional participation in geothermal investigations has persisted undiminished to the present day, not only in New Zealand but also in several overseas fields.

A gravity measuring instrument was brought to New Zealand in the late 1940s. Initially used in the Wairakei investigations, it became the basis for a country-wide survey of gravity which revealed unsuspected major features correlating with other physical characteristics of New Zealand, such as seismicity, as well as outlining major sedimentary basins of interest to oil exploration companies. The arrival of the major oil companies on the New Zealand scene in the mid 1950s allowed Geophysical Survey to concentrate on other types of exploration and on regional mapping. Aeromagnetic surveys, previously confined to the geothermal regions, have been extended over two-thirds of the country since 1969, and marine geophysical surveys are now extending previous measurements to the continental shelf.

Drilling

The drilling section was transferred from Geological Survey because much of its work involved shot-hole drilling for seismic surveys. During the past 15 years the work has broadened considerably to include stratigraphic drilling of all kinds. About 1000 bores aggregating over 30 km in depth have been drilled by the Division's two rigs since 1960, over 100 separate projects. The rigs have been used extensively in the initial investigations of many economic projects, the most successful being the ironsands investigations and the geothermal power schemes. The Drilling Section was responsible for the first exploration holes at both Wairakei and Kawerau.

The Division's drillers have made a special contribution in Antarctica. In 1960 they assisted with site investigations for a small nuclear power plant later used for McMurdo Station. Between 1972 and 1975 the joint US–NZ–Japan drilling programme in the Dry Valleys was entirely staffed by New Zealand drillers under the Geophysics Division drilling superintendent. Recently, the drilling team has become involved in overseas aid, drilling a series of bores to monitor and exploit the freshwater lens of Tonga for the Tongan Water Board.

Pacific Island Observatories

After World War I the New Zealand Government became responsible for the "Samoan Observatory", now Apia Observatory. It was staffed by expatriate observers from DSIR and the NZ Meteorological Office, with local assistants, until the independence of Western Samoa in 1963. The Observatory now has an entirely local staff and is controlled by the Western Samoan Government who take full responsibility for the meteorological programme. DSIR still funds the equipment and seconded staff required to operate the seismology and geomagnetism aspects of the observatory.

Rarotonga Observatory is a legacy of World War II radio propagation experiments. The ionospheric programme carried out there was augmented by the installation of a seismograph station in 1965, using US equipment. Both Apia and Rarotonga observatories are positioned to enhance the world-wide networks necessary for the study of the Earth and its upper atmosphere.

GRASSLANDS DIVISION

Fitzherbert West, Palmerston North
POSTAL ADDRESS: Private Bag, Palmerston North
TELEGRAMS: GRASSLANDS Palmerston Nth TELEPHONE: 68 019 Palmerston Nth
DIRECTOR: R. W. Brougham, DSc

Agronomy: J. A. Lancashire, BSc, MAgrSc.

Pasture Ecology: W. Harris, PhD *Cantuar*

Plant Breeding: W. Rumball, PhD *Massey*

Plant Nutrition: P. R. Ball, MAgrSc.

Genetics: K. K. Pandey, PhD *Lond,* DSc *Lond,* AIARI, FLS.

Turf: G. S. Robinson, MAgrSc.

Liaison: W. G. Thurston, BAgrSc.

REGIONAL STATIONS

KAIKOHE:
P.O. Box 194
P. J. Rumball, MAgrSc.

BALLANTRAE (Hill-country):
c/- Grasslands Division
Private Bag
Palmerston North.
D. A. Grant, MAgrSc.

LINCOLN:
c/- Crop Research Division
Private Bag
Christchurch.
E. W. Vartha, MAgrSc, PhD *Massey*.

GORE:
Private Bag
A. J. Harris, MAgrSc.

STAFF at 31-3-76: 51 scientists and 100 supporting staff.

Grasslands Division undertakes research in plant and pasture improvement and pastoral agriculture. Through a small network of Regional Stations these activities encompass the warm temperate regions of Northland centred at Kaikohe, South Island high country centred in the Mackenzie Basin, moist and wet North Island hill country centred in the lower Ruahine Range (Ballantrae), intensive Southland sheep-farming centred at Gore, dryland Canterbury regions centred at Lincoln and Kirwee, and alluvial flatlands centred at Palmerston North and the Kairanga Plains (Aorangi). By collaborative research efforts with the Ministry of Agriculture and Fisheries, the Forest Service, the agriculture faculties of universities, and progressive farmers, the Division's research effort, especially in plant improvement, is spread over most climatic and geographic regions of the country.

The Division also has a national responsibility for the production of elite seed (Nucleus and Breeders) of a large number of herbage varieties bred by the Division and for ensuring evaluations of these in many overseas countries for possible acceptance on the National Lists of Herbage Cultivars of these countries. In collaboration with M.A.F. it is involved in aspects of seed certification and evaluations of overseas herbage varieties for suitability of use in New Zealand agriculture. A seed introduction service for herbage plants is also provided for M.A.F., the agriculture faculties of universities, some units of the Forest Service and for the Division's own use.

Current projects

AGRONOMY: Species evaluations under mowing and grazing; aspects of pasture utilisation; plant and pasture establishment; seed production; seed certification.

ECOLOGY: Temperature, light intensity, and defoliation responses; plant and species competition; pasture "litter" ecology; buried seed studies; plant root studies; plant response to weedicides, pesticides and fungicides; plant distribution and successional changes; botanical characteristics of herbage plants.

GENETICS: Molecular and biochemical genetics; cyto-genetics; genetics of breeding systems and of rhizobia.

PLANT BREEDING: Main breeding efforts are —

Grasses: Ryegrasses; cocksfoot; timothy; *Bromus*; *Festuca* and *Lolium x Festuca* hybrids; browntop; crested dogstail; *Phalaris;* Yorkshire fog.

Legumes: White, red and alsike clovers; lotuses; *Ornithopus*.

Special Topics: plant breeding for better utilisation of phosphate, for tolerance to pasture pests and diseases, for improved nutritive value, for possible bloat resistance, and for improved N-fixation in legumes.

PLANT NUTRITION: Electro-physiology characteristics of plant roots; mechanisms of ion uptake; aspects of phosphorus, potassium, nitrogen, sulphur and minor element plant nutrition; nitrogen fixation and N-cycling in pastoral systems.

TURF RESEARCH: Fertiliser requirements of fine turf; turf management; turf variety evaluations; plant breeding for sports turf.

REGIONAL STATIONS: At all regional stations research effort covers species evaluations; for both the more promising experimental varieties and certified varieties investigations are designed to fit these varieties into agricultural practices in the region. These include botanical surveys, species and pasture establishment, species growth rates, pasture management and species performance, species evaluations, plant breeding, seed production, weed control, nitrogen fixation and mycorrhiza, plant nutrition and nutrient cycling, protein extraction and chemical composition of pasture, nutritive value of species and pasture, and animal disorders related to pasture varieties.

HISTORY AND ACTIVITIES

Grasslands Division was originally set up as part of the Plant Research Bureau in 1929, but it was not until 1936 that it was constituted in its present form.

At that time the Division's terms of reference were "the study of the environmental and hereditary factors influencing the growth of pasture plants, and their reactions within the grass–clover pasture; also their relationships with animal requirements and with crop production over the variable soil and climatic conditions of New Zealand. Parallel and integrated with such studies is the breeding of pedigree strains of pasture plants (excluding lucerne), the study of the field management of these strains, and the provision of nucleus pedigree seed to the Government seed certification scheme."

These terms of reference were defined by such people as A. H. Cockayne, then Director-General of the Department of Agriculture; Sir

Ernest Marsden, then Secretary of DSIR, Sir E. Bruce Levy, first Director of Grasslands Division; Sir R. G. Stapledon, former Director of the Welsh Plant Breeding Station; and Dr W. Davies, past Director of the Grasslands Research Institute, Hurley.

It soon became apparent that a small network of sub-stations would be essential if the Division's responsibilities of plant and pasture improvement for New Zealand's agriculture were to be successfully achieved. Thus sub-stations were set up as follows:

1938 LINCOLN. Officers based at this sub-station had the primary objective of fully identifying research problems in plant and pasture improvement for the dryland regions of New Zealand. They also have the responsibility of identifying and researching South Island high country problems based in the Mackenzie Basin.

1945 TE AWA. Situated in North Island hill country about 30 km north of Feilding, Te Awa provided scientists at headquarters of the Division in Palmerston North with a research area to study aspects of plant and pasture performance on moist to wet North Island hill country.

1945 GORE. Centrally situated in the intensive sheep-farming regions of Southland. Te Awa and Gore had some common features such as cold winters, reasonably even distribution of rainfall, a very accentuated late spring–early summer peak in pasture production, and the dominance of browntop as a pasture species.

1955 KAIKOHE. Developed on a raw gum-land soil, this station was established to extend into the warmer temperate regions of New Zealand the Division's plant and pasture improvement programmes as well as to achieve progress in pasture development in Northland.

1966 AORANGI. Situated approximately 20 km from headquarters on the Kairanga Plains, the "Aorangi" Research Area was purchased to complement the small land-holding available to staff of the Division at Palmerston North for plant and pasture research on alluvial flatlands.

1966 BALLANTRAE. Located in the lower Ruahine Ranges near Woodville, "Ballantrae" was purchased to replace Te Awa. This property was badly run down, liberally covered with secondary growth and was more typical of difficult North Island hill country than was Te Awa. In fact it is an ideal area on which officers of the Division can undertake research on all aspects of hill country pasture ranging from detailed soil, plant, and ecological studies through to more applied research on species performance under varying management systems with assessments of the effects of animals.

Some major achievements to date

Officers of Grasslands Division have made some major contributions to the development of New Zealand's pastoral agriculture during the past 40 years and in so doing have contributed very substantially to the nation's prosperity. They have also contributed significantly to the world's knowledge on temperate grasslands and agriculture, as well as assisting many thousands of overseas visitors to better understand pastoral agriculture in different regions of the world.

Early workers at the Division, such as Sir E. Bruce Levy (first Director of the Division, 1936–1950), the late Dr P. D. Sears (later Director of the Division, 1956–1963), Dr J. Melville (Director 1950–1955) and Dr R. H. Jackman were world leaders in research around the soil–plant–animal complex of grassland farming and in understanding and manipulating the "N-cycle" in New Zealand grassland farming. The Division, through the efforts of prominent plant breeders and strain ecologists such as Dr L. Corkill (Director of the Division 1964–1971), Mr L. W. Gorman, and the late Dr P. C. Barclay, has also been responsible for the introduction, breeding, and standardisation of 15 bred varieties of pasture plants.

Other major research efforts by the Division have been sustained work in hill country pasture development and farming, the analysis of factors affecting regrowth of pastures and seasonal patterns of production, and the understanding of interactions of the many factors influencing the establishment phase of pastures.

Future activities

Although New Zealand is still more than 80 per cent dependent on primary production for export earnings, production potentials are far from being realised in all regions of the country, the production processes in agriculture (soil–pasture–animal) are still not well understood, and alternative systems of food production are in their infancy. Farming systems that pay greater attention to more efficient use of resources (e.g. phosphate and energy) will be developed; and the need for sensible and planned development of our basic resource — land — is only just beginning to be realised.

Thus the terms of reference of Grasslands Division will be little different from those originally set down by that group of far-seeing scientists in 1936. The Division will need to remain multi-disciplined to achieve its objectives of plant and pasture improvement nationally. It will also need to have facilities to maintain research effort in the major climatic regions of the country, and the capacity to alter research programmes to meet changes in land use and farming patterns as these occur, as has been recently demonstrated by the marked increase in the Division's research activities in North Island hill country.

HOP RESEARCH STATION

Main Road, Riwaka
POSTAL ADDRESS: P.O. Box 36, Riwaka
TELEGRAMS: HOP RESEARCH Motueka TELEPHONE: 515D Motueka
SUPERINTENDENT: A. A. Frost, BScHort.

STAFF at 31-3-76: 1 scientist, 3 science technicians, and 1 supporting staff.

SITE AND CLIMATE

Lat.: 41°6S. *Soil:* Riwaka silt loam. *Rainfall:* 1372 mm per annum on 101 days; well distributed but slightly heavier in winter months. *Temperature:* Mean max. 18°c; mean min. 7°c; mean 12°c. *Days of ground frost:* 80. *Hours of sunshine:* 2 480.

The Station was established in 1951 after approaches to DSIR from brewing companies and hop growers. It is directly linked to, and partly funded by, the private sector. Its role is to breed and test varieties of hops for suitability to latitude and climate of the growing area, and to investigate methods of growing and drying hops to provide a high-quality product in the most economic manner.

Current Projects

BREEDING: As a result of earlier breeding programmes, the Station possesses a range of varieties with characteristics of high alpha acid, heavy cropping, and low seed percentage. These are, however, late in maturing, and present work has the aim of producing an earlier ripening race with similar characteristics. Also, seedlings are now being selected for new factors, including ease of machine picking, ability to produce a heavy crop in the absence of males, and resistance to red spider.

Non-cultivation techniques are being tried at the Hop Research Station to reduce labour costs. Photo shows an area of hops 4 months after sowing and spraying with simasine/paraquat. The plants are 2 m high and the ground bare and weed-free.

AGRONOMY: Several techniques are being studied with the object of reducing labour requirement and production costs, including non-cultivation techniques, such as herbicide usage and permanent grassing down, and minimal cultivation interspersed with short-term pasture. Also, the reduction of some operations on the hop plants themselves is under investigation.

PROPAGATION: The Station has introduced a method of producing large numbers of plants in a season from a single parent, by rooting small green shoots in polyethylene tunnels under shade. The technique is now being introduced to commercial usage, and it should quickly supplant the traditional layer system.

INSTITUTE OF NUCLEAR SCIENCES

Gracefield Road, Lower Hutt
POSTAL ADDRESS: Private Bag, Lower Hutt
TELEGRAMS: PHYSICAL Lower Hutt TELEPHONE: 666 919 Wellington
DIRECTOR: T. A. Rafter, O.B.E., DSc *Vic*, FNZIC, FRSNZ.
Accelerator Physics: G. J. McCallum, MSc, FInstP.
Mass Spectrometry: J. R. Hulston, PhD *McMaster,* FInstP.
Theoretical Physics: B. J. O'Brien, PhD *MIT*.
Nuclear Instrumentation: J. D. McCormick, CEng, FIEE.
Radiation Chemistry: H. C. Sutton, PhD *Durham,* FRSE.
Isotope Chemistry: W. J. McCabe, BSc.
Low Background Studies: H. S. Jansen, MSc.

STAFF at 31-3-76: 33 scientists, 21 science technicians, and 9 supporting staff.

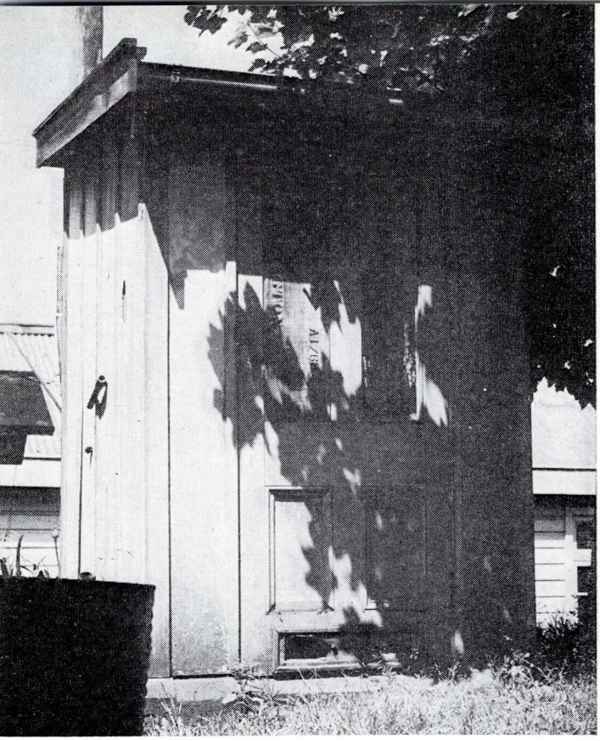
The Institute of Nuclear Sciences (INS) applies nuclear techniques to assist in the solution of problems in agriculture, human health, natural resources, industrial development, and the natural environment. INS originated partly from work begun in 1949 by T. A. Rafter at Dominion Laboratory, Wellington, and G. F. Ferguson at Dominion Physical Laboratory, Lower Hutt, in which the carbon-14 dating technique was developed to a high degree of experimental accuracy from principles enunciated three years earlier by Professor W. F. Libby. The successful use of radioactive isotopes in agricultural and medical problems made evident the need for increased nuclear research and more sophisticated equipment. Thus in 1959 INS was formally established as a separate division of DSIR, with T. A. Rafter as Director.

HISTORY AND ACTIVITIES

Radioactive dating

Radiocarbon dating facilities at INS have always been in demand both in New Zealand and overseas. They are presently used to date fossils and archaeological specimens up to 50 000 years old, volcanic ash showers, and soils and soil components. In 1958 Rafter and Ferguson showed that nuclear weapons testing had increased the level of carbon-14 in the atmosphere and oceans, and they initiated global studies on atmospheric mixing processes which continue today. Nuclear testing also increased tritium levels in rain water, so natural waters can be dated from their tritium content using techniques developed at INS.

A solid source mass spectrometer, used in the rubidium-strontium dating technique, was recently installed at the Institute. This will greatly extend the range of rock specimens of ages exceeding 10 000 000 years which can be dated. The method was used to show that the Constant Gneiss in Westland is 680 000 000 years old, thus providing the first direct evidence for the existence of Precambrian rocks in this country. Other dating techniques used at INS are based on lead-210, for lake sediments less than 100 years old; potassium-argon, for geological specimens over 1 000 000 years old; and certain uranium isotopes, for shells in Wanganui and soils in Niue over 100 000 years old.



Many DSIR divisions began work in far from ideal conditions. The early work on radiocarbon dating in New Zealand, which led to the formation of INS, was done in this shed.

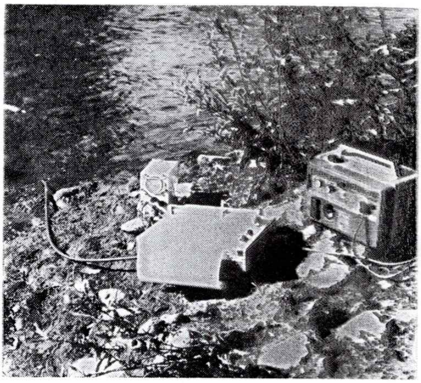
Mass spectrometry

The relative abundances of the stable isotopes of selected elements are determined accurately with specially constructed mass spectrometers. Small variations of these abundances occur in natural specimens of different origin. Interpretation of the variations in terms of age, temperature of formation, and chemical and biological environment has been applied to geochemical problems since this work began at INS in 1955. Work is now directed at determining temperatures of formation of ore deposits and of geothermal gases from isotope fractionation effects, using model systems calibrated in the laboratory. Hydrological investigations using stable isotopes and tritium to trace natural waters have been completed in the Rotorua lakes area, the Kaikoura Plains, and Marlborough. Recent studies in Canterbury indicate that the aquifer is fed by the Waimakariri River, which is important to the siting of the formerly proposed city of Rolleston.

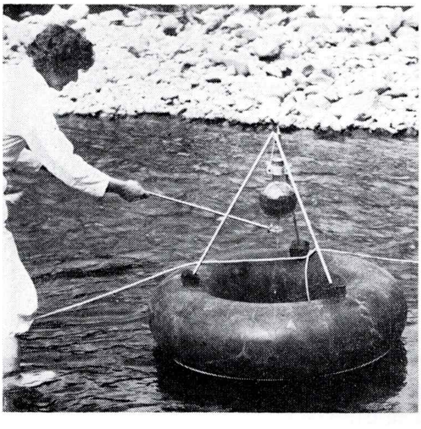
Substances artificially enriched in certain stable isotopes, e.g., nitrogen, have been used as tracers in agricultural and medical problems. Recently, this work has been extended to tracing nitrogen fertilisers and nitrogen fixation in agriculture and forestry research.

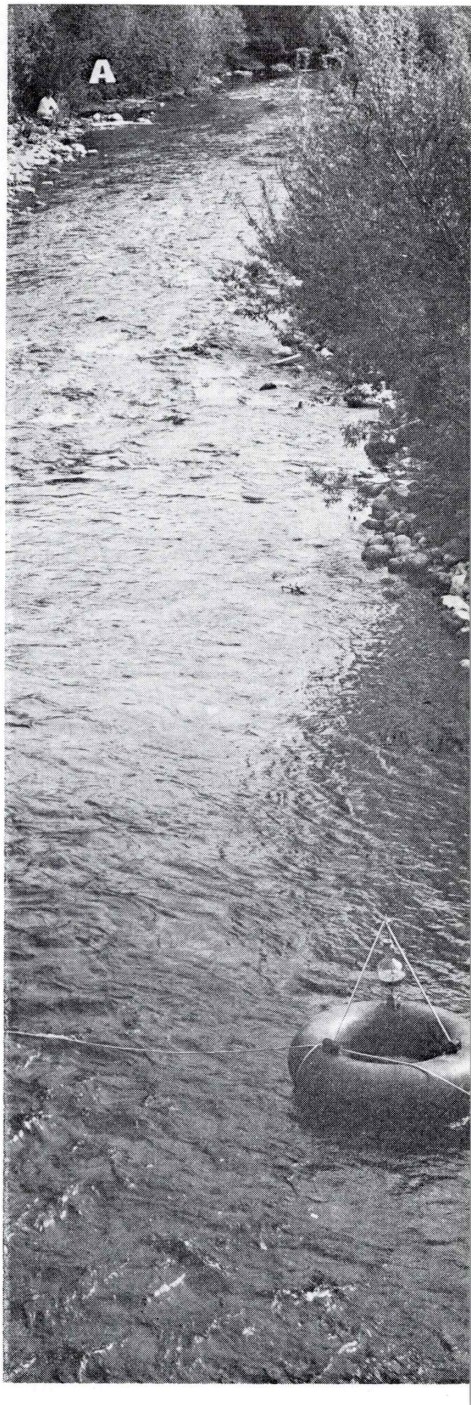
Nuclear physics

Research in nuclear physics began in 1965 after the 3 MeV Van de Graaff accelerator was commissioned. An early research highlight was the discovery in 1967 of a new isotope of arsenic (^{82}As). Also, the Institute was among the first to construct and use large volume, solid state, gamma-ray detectors. Short-lived isotopes of carbon, nitrogen, fluorine, and chromium have been produced for agricultural and medical applications, and a broad range of trace element determinations



Flow-rates of streams can be measured by radioactive tracers. The tracer is released (below) and its concentration downstream is measured with equipment (above) sited downstream at A (right). Stream flows from bottom to top of page.





has been made using both nuclear reaction techniques and X-ray and proton-induced X-ray fluorescence. Examples include the detection of lead near bullet holes, now in standard use for homicide cases; matching of glass specimens for forensic purposes; non-destructive trace element analyses of paint, face powders, matches, soil, narcotics, and hair; and detection of gold in blood cells.

A highly versatile, pulsed, nuclear-magnetic-resonance (NMR) spectrometer has been constructed at the Institute. A research programme will evaluate the potential of NMR techniques for the early diagnosis of cancer.

The International Atomic Energy Agency (IAEA) has initiated a computer-based information dissemination service covering all aspects of nuclear science. A current awareness service, using the magnetic tapes regularly distributed by IAEA, has been developed at the Institute; it is being used by research workers in the Government and universities.

Radiation chemistry

A small cobalt-60 source was set up at INS in 1959 to investigate useful applications of gamma radiation such as the preservation of food and creation of mutations in seeds. This was supplemented with electron beams from the Van de Graaff accelerator in 1966. INS contributed to the development in New Zealand of the sterilisation of medical products by radiation and provides dosimetry calibrations for this successful industry.

Present research in industrial topics includes the production of wood-plastic materials as a substitute for imported hardwoods. The Institute is also fulfilling long-term projects such as study of the chemistry of the superoxide radical ion and its role in biochemistry; development of methods of protecting plastics against UV and radiation damage; development of luminescent standards (this achieved international recognition in 1972 and is now being extended); and studies in radiation biology using bacteria as indicators of factors which alter the sensitivity and repair of cells exposed to ionising radiation.

Isotopes in industry

Early examples of the Institute's role in applying radioactive isotopes to industrial and medical topics included labelling fertilisers, assistance with the introduction of nuclear medicine, production of radioactive grout, and development of geiger tubes for use at high temperatures in geothermal well logging. Mobile facilities for radioactive tracer studies have been used to measure effluent dispersal at Titahi Bay, Manukau Harbour, on the Wanganui River, and, currently, the underground water movements at Broadlands. A technique based on attenuation or scattering of radiation, used formerly in wood density measurements, is now being applied to quality control in the manufacture of refractory bricks.

INS also monitors environmental levels of selected radioactive isotopes which occur naturally, and those from fallout; present emphasis is on plutonium and radon. Carbon dioxide levels in the atmosphere are measured continuously as part of a global survey.

OCEANOGRAPHIC INSTITUTE

177 Thorndon Quay, Wellington
POSTAL ADDRESS: P.O. Box 12346, Wellington North.
TELEGRAMS: RESEARCH Wellington TELEPHONE: 858 939 Wellington
DIRECTOR: J. W. Brodie, MSc.
ASSISTANT DIRECTOR: D. E. Hurley, PhD *NZ*.

GROUPS

Benthic ecology
Sedimentology
Regional and local structural marine geology
Physical and chemical oceanography
Coastal and sheltered water environment
Lake surveys

STAFF at 31-3-76: 25 scientists, 13 science technicians, and 8 supporting staff.

The New Zealand Oceanographic Institute was established to investigate the seas around New Zealand. This very broad charter has been developed along three main lines — *physical oceanography*, the study of water masses, currents and their properties, tides, and tsunamis; *marine biology*, the study of the living organisms of the sea, and *marine geology*, the study of the ocean floor and the processes involved in its development. In addition, the Institute has adapted marine techniques for research in New Zealand lakes, resulting, in particular, in the production of an extensive series of lake bathymetric charts.

It is the Institute's task to develop a knowledge of the sea, its life and processes, and to be able to provide the best possible advice to those involved in applied fields such as coastal and offshore engineering, disposal of thermal and sewage effluents, offshore mineral recovery and oil prospecting, fisheries research, preservation of the coastal environment, provision of coastal amenities, or even the information on which to base international boundaries. Nevertheless, its approach is essentially research-oriented; practical application comes from increasing knowledge of the fundamental processes involved in the dynamics and life of the seas.

The Institute's functions include: basic research on the marine environment; compilation of bathymetric, geological and sediment charts; research on the effects of effluents and pollutants on marine ecological systems, especially in the near shore; the supply of data and advice for applied projects (e.g. harbour works, coastal protection); exploration of marine mineral resources; studies of the dynamic processes of the oceans including upwelling, ocean currents, tides and tidal effects; and lake surveys.

Current projects

MARINE BIOLOGY: Benthic ecology of Manukau Harbour, Pauatahanui Inlet, and Tasman and Golden Bays; ecology and systematic studies of marine organisms; evaluation of primary productivity and nutrient status of New Zealand waters; the importance of coastal zooplankton in the food chain; studies of fouling organisms on power station systems; biological effects of thermal effluents.

PHYSICAL OCEANOGRAPHY: Microstructure of seawater; development of instrument packages for accurate water measurement of deep water properties; studies of circulation and seawater properties on the west coast of North and South Islands; circulation of the Kermadec and Bounty Island regions; detailed studies of the mid-Tasman convergence; hydrological regimes in coastal inlets; tidal recording; detailed studies of coastal tidal regimes; circulation under the Ross Ice Shelf.

CHARTS: Production of coastal, oceanic and lake bathymetric charts; charts of sediment and marine mineral distribution.

MARINE GEOLOGY: Seafloor geology off the west coast, North and South Islands; surface and sub-surface sediments and structures off South Taranaki and mid-Canterbury; transport of inorganic and biogenic shelf seston (suspended sediment): development of an instrument package to measure seabed boundary conditions of current velocity, pressure fluctuation, variability of sea surface, and sediment movement; sediment transport in Wellington Harbour; Quaternary stratigraphy of shelf and deepsea areas using coccolith and diatom studies; structure and tectonic history of the New Zealand region; geology of the New Caledonia and South Fiji Basins.

MINERAL EXPLORATION: Manganese nodule distribution in the South West Pacific; phosphate and glauconite distribution on the Chatham Rise; offshore ironsand distribution on the west coast of North and South Islands.

PAUATAHANUI ENVIRONMENTAL PROJECT: Multi-disciplinary studies of Pauatahanui Inlet include work on bathymetry, morphology, sediment distribution and transport, littoral and shallow-water ecology, water circulation and properties, and solar heating of intertidal mudflats.

BIBLIOGRAPHY: To assist with background information on areas presently being investigated, a series of bibliographies have been commissioned. Recently published or completed bibliographies cover Pauatahanui Inlet; Wellington Harbour; Tasman and Coral Seas; geology of Cook Islands, Niue, Tonga, and Samoa; marine oil spills; estuaries; manganese nodules; mangroves in New Zealand; New Zealand marine geology; heated effluents; Marlborough Sounds. Others in preparation deal with Kaipara Harbour, Castlepoint areas, Lakes Te Anau and Manapouri, and Foveaux Strait.

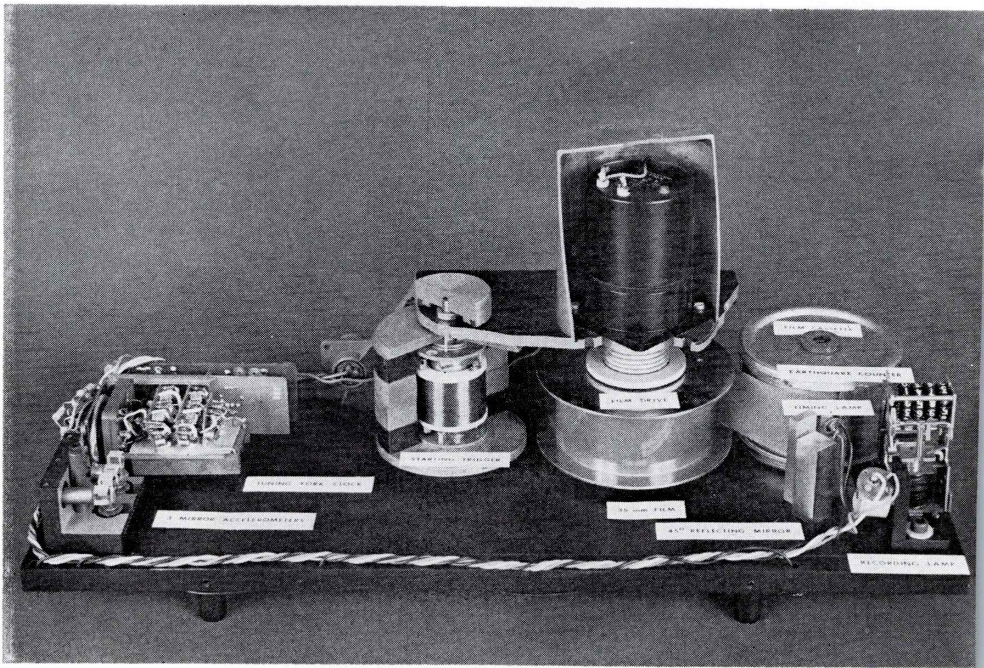
HISTORY AND ACTIVITIES

In 1975 the Institute celebrated its 21st anniversary with a reunion of past and present members and a two-day seminar to mark the development of the Institute from its first beginnings in 1949 as the Oceanographical Observatory of Geophysics Division under the late W. M. Jones. In 1954, the Institute was constituted a separate section serviced by Geophysics with Mr J. W. Brodie as Superintendent. It became a fully-established Division in 1958.

In its early days, shiptime was provided by sharing HMNZS *Tui* with Naval Research Laboratory. As the research needs of the two institutions grew *Tui* alone could no longer supply sufficient seatime for both, and the Institute began chartering vessels, using first M.V. *Viti*, a 48.5 m cargo vessel, from 1959 to 1961, then the 63.4 m *Taranui* from 1962 to 1971. Also of value was time offered by the Navy on various ships, particularly the two Antarctic supply vessels successively named *Endeavour*. These were used for research south of New Zealand, in the Ross Sea, and occasionally in the Pacific. With changing shipping patterns, chartering became no longer practicable, and in 1972 DSIR purchased the 75 m *Wellington Exporter* which was recommissioned in 1973 as R.V. *Tangaroa*. A vessel of 1035 gross tons, *Tangaroa* has accommodation for eight scientists and is well equipped with laboratories and essential oceanographic equipment: satellite navigation for accurate off-shore position fixing, deep echosounding and seismic profiling equipment, sidescan sonar and magnetometer, and facilities for biological and geological research as well as physical oceanography.

The Institute has occupied a variety of buildings, from its original hut owned by the Royal Society in Kelburn to Lambton Quay and then to Thorndon Quay with occasional incursions into Hobson Street. Plans for a new building at Evans Bay with wharf and aquarium have met with various set-backs over the years but now appear near realisation.

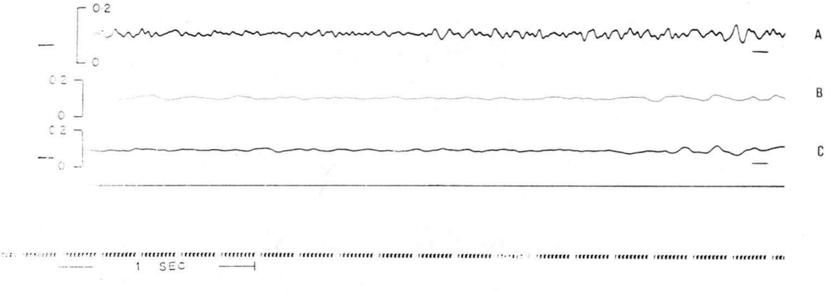
When the Institute began, its role in relation to the community was still to be established but there is now a growing acceptance of its role in fundamental research and an expanding demand for advice in the various fields of applied marine research.



The strong-motion earthquake recorder (*cut-away model above*) measures earthquake accelerations, not displacements as in conventional seismographs. It is activated by an earthquake and automatically produces a continuous film record showing motion in three directions. There is a network of 117 recorders throughout New Zealand, of which 30 are in Wellington, mainly in multi-storey buildings to monitor the movement of structures during earthquakes.

The record below was made by an instrument at Maruia Springs during an earthquake of magnitude 5.9 on the Richter scale at Reefton, about 20 km away. The bottom line shows time elapsed; the top line (A) records the vertical component of the pressure waves (P waves) which in this case arrived about 3 seconds before the two horizontal components (B, C) of the shock (S) waves.

These recorders were developed by the Physics and Engineering Laboratory and are manufactured locally; many have been exported.



PHYSICS AND ENGINEERING LABORATORY

Gracefield Road, Lower Hutt

POSTAL ADDRESS: Private Bag, Lower Hutt TELEPHONE: 666 919 Wellington
TELEGRAMS: PHYSICAL Lower Hutt TELEX: PHYSICS NZ3814
DIRECTOR: M. C. Probine, PhD *Leeds*, FInstP, FRSNZ.

Chief Engineer: A. H. Allan, BE Elec Civil (Hons).
Applied Physics: A. H. McIlraith, PhD *Canty*, FInstP.
Biophysics: J. H. Troughton, MAgrSc, PhD *ANU*.
Physics: M. A. Collins, MSc, CEng, FInstP.
Mechanical Engineering: D. G. McCulloch, BSc, CEng.
Electrical Engineering: R. A. Morris, BSc.
Upper Atmosphere: G.McK. Allcock, MSc, FInstP.

SUBSTATIONS

CHRISTCHURCH: Geophysical Observatory, St. Elmo Courts P.O. Box 2111. Telephone: 65 349. R. S. Unwin, BSc, FInstP.

LAUDER, CENTRAL OTAGO: Auroral Station, Omakau. Telephone: 585. Telex AURORA NZ5637. J. G. Keys.

STAFF at 31-3-76: 92 scientists, 117 science technicians, and 49 supporting staff.

The Laboratory's functions include: basic and applied research in physics and engineering; maintenance of national standards of physical quantities such as length, mass, temperature, etc.; provision of a calibration service for physical measuring equipment; introduction and development of new technology suited to New Zealand's requirements and promotion of its effective use in industry; maintenance of a workshop giving industry access to specialised machine tools and new machine techniques; and operation of geophysical observatories at various stations for ionosphere and magnetic observations.

Current Projects

EARTHQUAKE ENGINEERING: dynamic testing and analysis of large buildings; maintenance of accelerometer work throughout New Zealand to measure ground and building behaviour; consultation on bridge design; development of energy absorbers to reduce structural damage to buildings and bridges; dynamic microzoning studies.

GEOPHYSICAL METROLOGY: recording and analysis of earth strain at tunnel sites; development of equipment for measuring earth tilt.

MECHANICAL ENGINEERING: development of small-scale automation; mechanical testing of components and materials; mechanical engineering design; strain-gauge measurements for industry; calibration of anemometers; numerical control advisory service for industry; development of continuous enzyme recovery equipment; development of techniques for high-speed photography.

INDUSTRIAL ENGINEERING ADVISORY SERVICE: engineering management advisory services; advice on selection and use of computers; inter-firm comparisons in the scouring industry; investigation on the feeding of wool to wool scours and dryers.

ENGINEERING METROLOGY: maintenance of New Zealand standards of length, mass, pressure, and force; calibration of mechanical measuring equipment for industry; development of measurement methods in engineering metrology; inspection and certification of components, tooling, and gauges.

ACOUSTICS: research on impulse noise; reverberant-energy measurements; advice and measurement on industrial, traffic, and aircraft noise; measurement and research on air-blast circuit-breaker noise levels; development of new techniques in acoustic measurement; development of sound-absorption test methods.

ELECTRONIC DESIGN: automatic weighing, grading, and marshalling of carcasses for the meat industry; computer control of spray drying milk powder; development of automated experimental data collection for various PEL groups; investigation of the design of high-voltage insulators; advisory service, testing, and measurement for industry; development of industrial test facilities.

ELECTRICAL STANDARDS: establishment and maintenance of New Zealand standards of electrical quantities and frequency; development of calibration facilities; calibration of electrical equipment; research on VLF transmission of standard frequency signals; advice on location of transmitters and translators in alternative sites to national parks, etc.

WORKSHOP SERVICES: advice to industry on machining methods; provision of special machining facilities; construction of special tools and gauges for industry; provision of workshop services for DSIR; development of scientific instruments for research and development in Government departments.

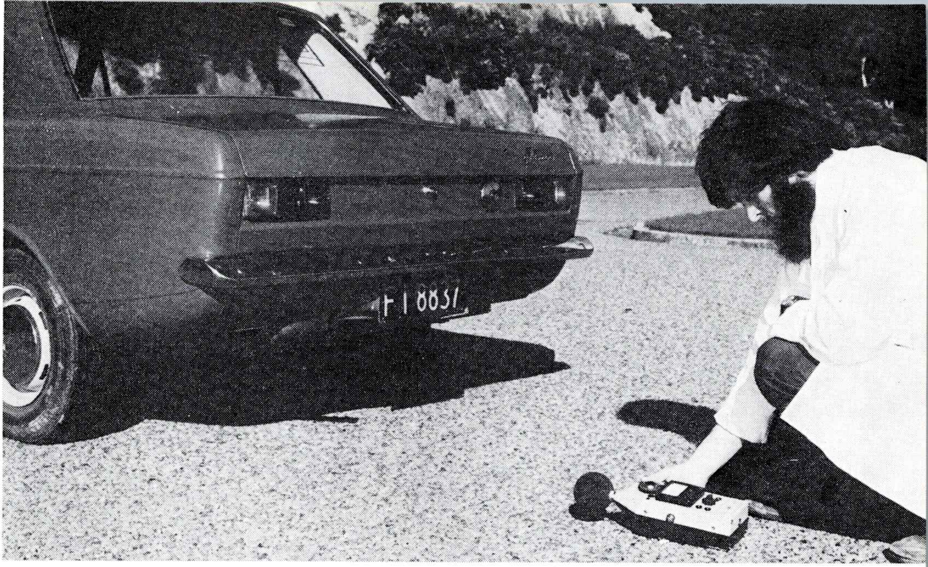
REMOTE SENSING: development of techniques for using remote sensing for resource surveys; and for interpreting remote sensing data from earth satellites and aircraft.

OPTICS: research and development in geometric optics; development of special optical systems for research and industrial applications; development of computer techniques for lens design.

PHOTOMETRY: maintenance of New Zealand standards of photometric quantities; testing and calibration of photometric equipment and systems; measurement of beam intensities of lighthouses; research on road lighting systems; effect of lighting on road safety.

MATERIALS SCIENCE: research on mechanical damping in alkali halides; development of extrusion-energy absorbers for earthquake-engineering applications; development of a simulation computer program for research on temperature effects in metals at pre-melting temperatures.

MOLECULAR PHYSICS: research on ultrasonically modulated electron resonance (UMER); electron-spin-resonance studies of unstable radicals by "spin trapping"; action spectra of radiation damage in wool; design and construction of a CO_2 laser for research and for metal-cutting applications; development of a simulation computer programme for



Road traffic has been identified as the main source of community noise in many urban areas. For smaller cars the dominant source of noise is the exhaust. PEL has developed for the Ministry of Transport a test procedure well suited to routine roadside service checks.

research on the automation of milk drying; stress dependence of second harmonic generation from a CO_2 laser.

BIOPHYSICS: research on the mechanical properties of wood in relation to its microstructure and moisture content; measurement of the elastic properties of hemi-cellulose and lignin; research on the structure of New Zealand woods; energy farming; study of translocation in plants using the isotope C-11; research on gas exchange in biological systems; research on the properties of stable foams in relation to bloat in animals and to pollution research.

ELECTRON MICROSCOPY: research on membrane structure in biological systems; research on insect sensors; provision of advice and assistance in electron microscopy for a wide range of institutions and organisations; research on morphology of insects' cuticular structure; theoretical studies on new models of the biological cell; research on rainfall interception properties of plants; research on insulation failure.

APPLIED MECHANICS: development of a computer model of the Hutt Valley aquifer in relation to aquifer management and avoidance of salt water intrusion; geothermal reservoir studies.

HEAT TRANSFER: development of solar water heaters; advice to industry on heat-exchanger design; thermal testing, calibration work, and information service for industry; development of microcalorimeter for biological applications.

TEMPERATURE STANDARDS: maintenance of New Zealand standards of temperature; calibration and testing work; development of methods for accurate reproduction of temperature and instrument calibration; measurement of freezing rate of specimens injected in freezing liquids.

UPPER ATMOSPHERE PHYSICS: engineering studies of high-frequency mobile communication systems; research on TV forward scatter; co-ordinated polarimeter and photometer studies of the ionosphere using geostationary satellite transmissions; development of an acoustic radar for air-pollution research; study of radio transmissions in the whistler mode; maintenance of an ionosonde network in the Pacific, New Zealand, Campbell Island, and Scott Base; operation of a telemetry station for acquiring data from Alouette/ISIS satellites; auroral-radar research; study of relationships between ionospheric and meteorological phenomena.

MAGNETIC SURVEY: maintenance of the National Observatory at Amberley; study of magnetic variations and their causes; magnetotelluric sounding; magnetic effects of high-altitude explosions; calibration of aircraft compasses.

COMPUTING: operation, maintenance, and development of software systems for the DSIR Gracefield computer terminal.

HISTORY AND ACTIVITIES

The Physical Testing Laboratory was formed in 1939, and in 1946 it amalgamated with the Radio Development Laboratory to become the Dominion Physical laboratory.

The establishment of PTL was part of a development programme started by Dr (later Sir Ernest) Marsden to expand research facilities to aid industry by the development of physical testing and by the provision and calibration of national physical standards. In 1925, as Chairman of a committee to enquire into the expansion and co-ordination of Government research, he said that industrialists must realise that quality of goods depends on definite measurable properties, and that measuring apparatus and facilities for all kinds of measurements was the best way in which they could be helped.

Dr Marsden's recommendation was adopted and functions of the Dominion Laboratory were extended to provide a wider range of physical measurements and tests.

The amount of physical work increased rapidly over the succeeding years, and after the declaration of war the Physical Testing Laboratory was constituted (on 12 September 1939) under the directorship of Dr Cooper. It was allocated premises at 54 Molesworth St, Wellington, and was moved to new and larger premises at Gracefield in 1942.

The Government's decision to manufacture certain type of munitions in New Zealand during the war meant that, as more and more New Zealand factories were required to provide munitions, there was urgent need for thousands of gauges to standardise parts for fully interchangeable assembly. DPL was logically the reference authority for certification for all gauges used in such manufacture, and throughout the war the New Zealand Munitions Controller used, to the full, all facilities of the laboratory.

PEL's other parent was the Radio Development Laboratory, which also had its origins in 1939 when DSIR was made responsible for radar development. The first Director was Mr C. M. N. Watson-Munro.

During the war RDL did an excellent job. The manuscript record of DSIR's World War II work states:

> "Radar . . . was the biggest single war project of the Department . . . a new and very wide field of scientific and engineering deveolpment was relatively suddenly opened up . . . to be developed intensively, and in secrecy, under the urgency of war . . ."

At the end of the war the Department transferred radio and radar development to DPL, which could then begin the functions proposed for it as follows in the Heath Report of 1926:

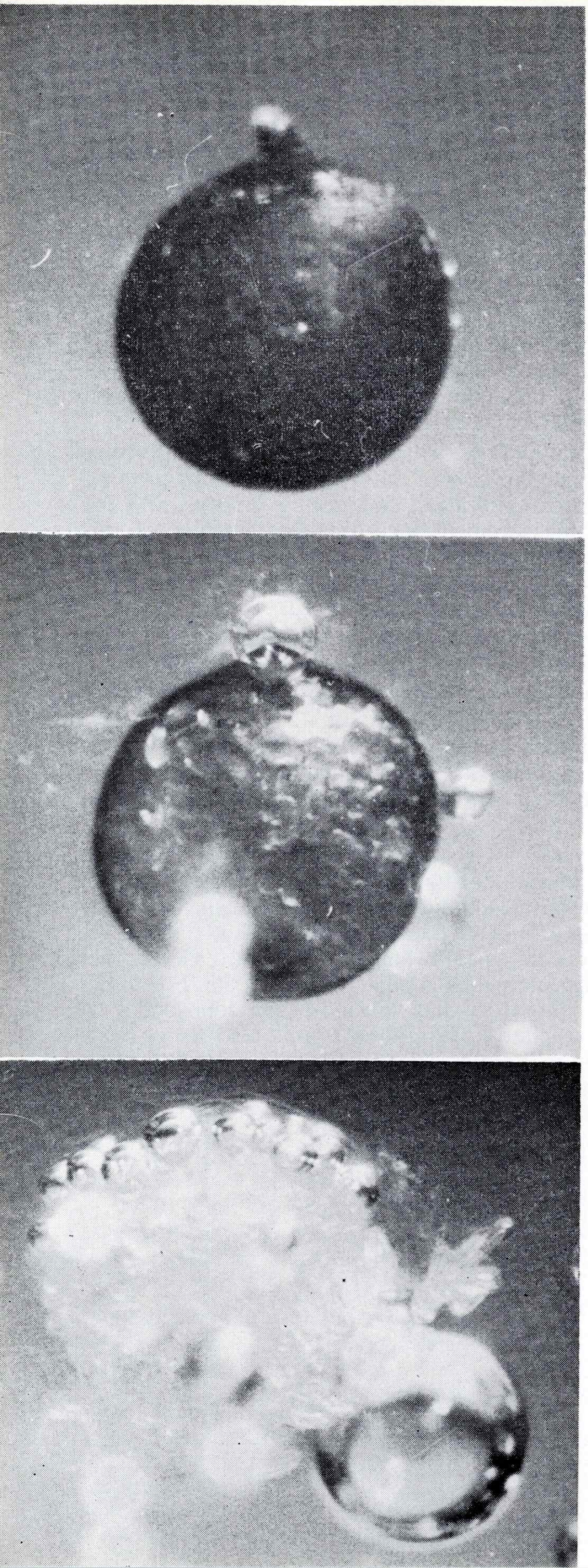
> "There is general agreement that a start should be made on the foundation of a national laboratory for testing and investigating materials and scientific apparatus, and for the establishment of constants and standards in collaboration with the National Physical Laboratory and the other great laboratories of the same kind."

It is clear that the "founding fathers" saw one of the important roles of the laboratory as being the provision of national standards of physical quantities, the development of calibration and testing services, and the provision of all kinds of measurement facilities. The wisdom of this policy has never been more apparent than now, when industry is demanding a wider range of measurements, to a higher degree of accuracy, as it becomes more sophisticated and export-oriented.

Industry has also been assisted through the provision of specialist advisory, consulting, and liaison services; through research and development in areas of special industrial importance; and through the introduction and promotion of new technology.

Research of national importance done by PEL includes earthquake engineering; solar energy; geothermal reservoir studies; remote sensing of earth resources; electronics; materials science; radio communications; and acoustics.

The laboratory also has international responsibilities in upper atmosphere research and in monitoring the geomagnetic field and its secular variation in the New Zealand sector. There are magnetic observatories at Amberley, Apia, and Scott Base, and some other stations are occupied every two years or so (in conjunction with Geophysics Division) to check magnetic anomalies, secular variation, etc. For upper atmosphere research the laboratory has ground-based ionosondes at Rarotonga, Auckland, Christchurch, Campbell Island, and Scott Base; a satellite command station at Lauder, Central Otago; an auroral radar at Slope Point, near Invercargill; and other equipment at Lower Hutt, Campbell Island, and Scott Base.



Plant Diseases Division has shown that immersion of seed potatoes in sodium hypochlorite is effective in stopping the spread of potato cyst nematode into uninfected areas. Shown here is the sequence of disintegration of a single cyst.

Upper: Immediately on immersion small bubbles form on the cyst surface.

Centre: After 10–15 minutes the cyst-wall is almost transparent.

Lower: Finally, the wall disintegrates and juvenile nematodes, etc, within the cyst are killed as the chemical penetrates exposed egg masses.

PLANT DISEASES DIVISION

120 Mount Albert Road, Auckland 3
POSTAL ADDRESS: Plant Diseases Division, DSIR, Mt Albert Research Centre, Private Bag, Auckland
TELEGRAMS: PLANTLAB Auckland TELEPHONE: 861 059 Auckland

DIRECTOR: E. G. Bollard, PhD *Cantab,* FRSNZ, FNZIC.

Bacteriology and Virology: D. W. Dye, BAgrSc, PhD *Edin.*
Mycology: P. J. Brook, PhD.
Plant Protection: K. M. Harrow, MAgrSc.
Nematology (jointly with Entomology Division): F. H. Wood, PhD.
Pomology and Processing: G. Strachan, BS *Oregon S.*
Basic Science: R. L. Bieleski, PhD *Sydney,* FRSNZ.
Scientific Liaison: G. C. Weston, MA *Oxon.*

SITE AND CLIMATE

Lat.: 36°54′S. *Long.:* 174°44′E. *Altitude (climatological station):* 41 m. *Area:* 12.5 ha. *Soil type:* Basalt from volcanic cone of Mount Albert, overlying argillaceous sandstone; where sandstone is exposed the soil is podzolised. *Rainfall:* Average 1 356 mm per annum on 143 days, almost evenly distributed throughout the year, greatest from May to August and least from November to March. *Temperature:* Mean maximum 19°C; mean minimum 11°C; mean 14.5°C. *Days with ground frost:* 17. *Hours of sunshine:* 2 102 (Albert Park).

RESEARCH ORCHARDS

Kumeu (Auckland); Oratia (Auckland); Te Puke (Bay of Plenty); Havelock North (Hawke's Bay); Appleby (Nelson); Earnscleugh (Central Otago); Totokoitu, Rarotonga (Cook Islands).

VEGETABLE AREA

Pukekohe (South Auckland).

SUBSTATIONS

PALMERSTON NORTH: c/- Grasslands Division. G. C. M. Latch, PhD *Wisc.*
LINCOLN: c/- Crop Research Division. F. R. Sanderson, PhD *Mch.*

STAFF at 31-3-76: 54 scientists, 66 science technicians, and 36 supoprting staff.

The Division is responsible for research on the nature and control of fungous, bacterial, virus, nematode, and physiological diseases of all economic crops; the taxonomy of fungi and bacteria; plant physiological studies, especially mineral nutrition and growth substances; and the production, storage, and processing of vegetables and pip, stone, citrus, and subtropical fruits. A research station has been established since 1973 in Rarotonga, Cook Islands.

Current Projects

BACTERIOLOGY AND VIROLOGY: control of bacterial diseases in orchard trees, field crops, vegetables, and horticultural plants; taxonomy of plant bacteria; use of bacteria in agriculture, nitrogen fixation by *Rhizobium* and *Azotobacter,* use of bacteria antagonistic to pathogens; national reference culture collection of plant bacteria and fungi; identification and control of viruses of economically important plants; studies of virus transmission methods and identification of insect vectors; production and maintenance of virus-free clones of deciduous fruits and grapevines.

MYCOLOGY: studies of fungi causing damping off and root rots of horticultural and field crops, pasture plants, and trees; fungi causing airborne diseases of pasture plants, maize, berry fruits, grapevines, tree fruits, and a variety of vegetable and arable farm crops; diseases of turf; climate in relation to epidemics; pasture fungi in relation to animal disorders; taxonomy of New Zealand fungi and maintenance of a herbarium; relations of imperfect to perfect stages of fungi; records of plant pathogens in New Zealand.

PLANT PROTECTION: chemical and other means of controlling fungus and nematode diseases in field crops, fruit trees, vegetables, ornamental plants, and stored produce; seed pathology; control of insect vectors of virus diseases.

NEMATOLOGY: joint programme with Entomology Division (*see* p. 124).

POMOLOGY AND PROCESSING: evaluation of varieties, rootstocks, and cultural practices for temperate and subtropical fruits; crop forecasting; prevention of frost injury; chemical regulation of plant growth; preservation of fruits and vegetables by canning, freezing, dehydration, and chemical methods; post-harvest physiology and control of storage disorders; chemical composition of fruits and vegetables.

BASIC SCIENCE: regulation of plant metabolism; mineral nutrition of plants, particularly nitrogen, calcium, and phosphorus; transport of solutes in higher plants and in fungi; physiology of mycorrhizas and fungi; chemistry of bacterial and fungous toxins; detection, estimation, and synthesis of biologically active compounds; sterile culture of plant tissues.

HISTORY AND ACTIVITIES

In 1928 the Plant Research Station, administered jointly by the Department of Agriculture and DSIR, was established at Palmerston North. The scope of plant pathology research carried out by the Station's Mycological Laboratory increased greatly during the next 8 years. After a reorganisation of agricultural research in 1936, members of the Laboratory formed the nucleus staff of the new Plant Diseases Division (PDD), with G. H. Cunningham as Director. The Division was made responsible for research in plant pathology, pomology, and some aspects of entomology. Headquarters were located at Auckland because its climate suits most New Zealand crops and also favours diseases and pests.

An area of 6.7 ha was purchased on the north-eastern slopes of Mt Albert, and the laboratory (now called the Cunningham Building) and glasshouses were opened in 1939. In 1948 Fruit Research Division was formed at Mt Albert from the fruit research component of PDD, with J. D. Atkinson as Director. E. E. Chamberlain was Director from 1957 to 1968. The two divisions re-amalgamated in 1969 under Atkinson.

The original objectives of PDD were, broadly, to carry out research leading both to the control of diseases and pests of economic crops and to improvements in the fruit-growing industry. The programme today covers essentially the same range of interests, although responsibility for research on insect pests and their control was transferred in 1956 to Entomology Division.

Identification and recording of New Zealand plant diseases are continuing activities. The Division's first list, published in 1939, contained 411 diseases; the most recent list (1969) contained 894; and the list in preparation will probably record a further 200 diseases. Plant diseases in certain South Pacific territories are also being surveyed. Disease identification work is supported by taxonomic research on fungi and plant-pathogenic bacteria. The herbarium of fungus specimens and the reference culture collection of bacteria at Mt Albert form an integral part of this research. Plant indexing, electron microscopy, and serology are used in identification of viruses. The taxonomy of plant nematodes is a joint project with Entomology Division.

Studies of the biology of micro-organisms causing plant diseases, and research on relations between weather, crop growth, and the development of disease, have been aimed at disease control using cultural methods, chemicals, and biological antagonism. PDD collaborates with plant breeders in the selection of disease-resistant varieties, and new techniques allow provision to the industry of virus-free clonal material of vegetatively-propagated plants, such as apples or grapevines.

Disease control in horticultural crops is often achieved with fungicide sprays, and the Division ran a testing and certification scheme for evaluating spray chemicals until the Agricultural Chemicals Board became responsible for pesticides registration in 1959. Since then PDD has worked towards greater precision, efficiency, and economy in the use of fungicides and bactericides.

A farm at Pukekohe has been used since 1967 for field work on vegetable diseases. The Division also has a substation at Lincoln (established 1938) associated with Crop Research Division, studying diseases of crops, e.g., cereals, grown mainly in southern New Zealand. Another substation at Palmerston North (1961), associated with Grasslands Division, studies diseases of pasture plants. The work on disease control in field crops and pasture plants is closely linked with work on plant breeding and selection.

Over the years fruit research has been concerned with the whole sequence of fruit production (bud definition, the breaking of dormancy, flowering, pollination, fruit set, fruit development, and maturation), the nutritional requirements of orchard crops, the effects of nutrient imbalance on fruit storage quality, and requirements for the storage and transport of fruit. Other interests include irrigation, the use of plant hormones to regulate fruit production, and protection of buds from frost injury. These aspects are supported by basic research in biochemistry and plant physiology.

Assessment of new fruit varieties and new rootstocks is a continuing activity. Besides pip and stone fruits, PDD has studied nut varieties, new exotic fruit species, and subtropical fruits such as Chinese gooseberry, tamarillo, and citrus. Efforts have been made to increase the production of high-quality fruit from established commercial varieties. For these activities and for work on disease and pest control, the Division uses research orchards in Auckland (established 1940 and 1976), Central Otago (1947), Nelson and Hawke's Bay (both 1948), and the Bay of Plenty (1970). In 1973 research started at a station in Rarotonga on all aspects of the production of South Pacific crops.

The Division, recognising the importance of fruit and vegetable processing, began active work in this field in 1964, using a building donated by industry. Research is aimed at the production of commodities such as juice concentrates and essences for export, and at the manufacture of better juices and solid products for the home market. Work has mainly involved apple and citrus fruits, but assessments have been made of the suitability for processing of kiwifruit and tamarillo—fruits which at present are exploited commercially only in New Zealand.

Horticulture problems have required more fundamental work on some aspects of plant growth. For example, study of the factors governing storage quality in apple fruits led to the isolation and characterisation of zeatin, the first of a new group of plant-growth-regulating substances, and concern with nutrient deficiencies has led to a better understanding of the biochemistry of nitrogen, phosphorus, and other elements in plants.

Research at PDD has also included short- and long-term projects in microbiology. The Division has long been concerned with the selection, testing, and propagation of efficient strains of nitrogen-fixing bacteria for legume inoculation and from the 1930s to the mid-50s supplied inoculum for this purpose directly to farmers throughout New Zealand. Work in the early 1950s led to the commercial method for protecting timber from rot and insect attack, by diffusion impregnation with boron compounds. This process is now used on almost half the sawn timber treated in New Zealand for light building construction.

Since 1939 there has been a steady growth in Divisional responsibilities, a corresponding increase in staff numbers, and a need for more complex equipment and expanded facilities. As part of a long-standing plan to group DSIR divisions with related interests in a few main centres, the Hamilton Building was opened at Mt Albert in December 1973, enabling the headquarters of Entomology Division to shift from Nelson to Auckland. The two divisions retain their separate identities, but benefit from being able to share facilities and equipment, and work closely together on collaborative projects.

PLANT PHYSIOLOGY DIVISION

Palmerston North
POSTAL ADDRESS: Private Bag, Palmerston North
TELEGRAMS: PLANTPHYS Palmerston North
TLELPHONE: 68 019 Palmerston North
DIRECTOR: J. P. Kerr, PhD *Wisc.*

Crop and Forage Development: A. O. Taylor, PhD *Vic.*
Climate Room Service: I. J. Warrington, MHortSc(Hons).
Plant Biochemistry: C. R. Slack, PhD *Nottingham.*
Crop Physiology: H. G. McPherson, PhD *ANU.*
Tissue Culture and Genetic Engineering: W. D. Sutton, PhD *Otago.*
Agricultural Physics: K. C. McNaughton, PhD *UBC.*
Instrument Systems: R. W. Robotham.

STAFF at 31-3-76: 28 scientists, 20 science technicians, and 7 supporting staff.

Research is directed towards understanding the physiology governing the adaptation of plants to the New Zealand climate. Investigations involve complementary controlled-environment and field studies. Core disciplines are crop and plant physiology, plant biochemistry, agricultural physics, genetic engineering, and agronomy.

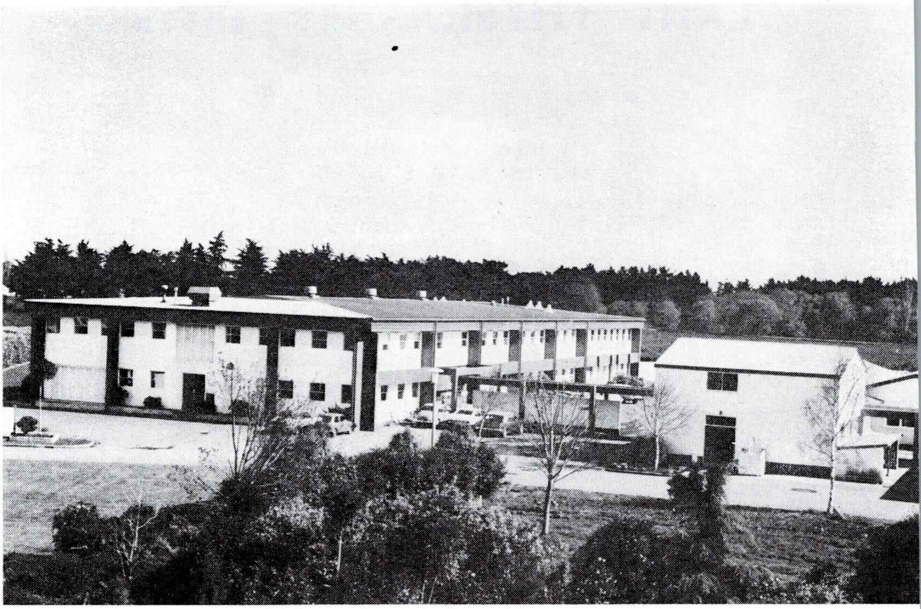
Current Projects

CLIMATE LABORATORY: effect of climatic variables on lucerne regrowth; partitioning of growth in ryegrass; the growth of tobacco varieties; infection of pines and poplars by fungal pathogens; heritability of cool tolerance in sorghum; effects of water stress on yields of safflower and wheat, leaf expansion of prairie grass and CO_2-assimilation in maize; the biological estimation of magnesium availability in Taranaki soils; heat therapy of virus-infected plants; and the effect of temperature on bud abortion of Chinese gooseberries.

FORAGE AND CROP DEVELOPMENT: evaluation of forage-crop based, conserved feed systems; temperature adaptation studies on winter-growing legumes, cereals, and brassicas; development of maize populations with better cool-season growth, and forage oats with improved rust resistance and protein content; studies of chilling-induced pollen abortion in sorghum; frost hardiness of summer grasses; field evaluation of summer grass introductions in Northland in pure and mixed swards; basic studies of photorespiration in plants.

PLANT BIOCHEMISTRY: study of the biosynthesis of polyunsaturated fatty acids in plants; study of carbohydrate accumulation in leaves of paspalum, *Digitaria,* and tomatoes grown in the Climate Laboratory; examination of the potential use of a highly active cellulase to make laboratory assessments of the digestibility of forage crops.

CROP PHYSIOLOGY: water-use adaptation to drought in maize; sensitivity of vegetative production to plant desiccation; diurnal and seasonal changes in water potential and stomatal resistance of irrigated and stressed apple trees; yield response of maize grain and silage to irrigation; gas exchange measurements of photosynthesis and stomatal response to drought in maize; development of a rapid-response wickless psychrometer for gas exchange studies.



Much of Plant Physiology Division's formative years was spent in establishing a suite of climatically controlled rooms as a national research facility. The building that resulted from this work has 24 such rooms and ancillary office and laboratory space.

TISSUE CULTURE AND GENETIC ENGINEERING: clonal propagation of asparagus, lily, and chrysanthemum cultivars by tissue-culture methods; conditions for virus and viroid elimination from plants; differentiation of *Pinus radiata* and poplar species from callus cultures; introduction of nitrogen-fixation genes into fungi; protoplast fusion; metabolism of detached lupin root nodules in culture; control of cell division and gene expression in nitrogen-fixing bacteroids; involvement of plasmid-borne genes in the *Rhizobium*–legume symbiosis.

AGRICULTURAL PHYSICS: studies of advective effects on evapotranspiration; water balance of winter-forage oats; construction of a weighing lysimeter for evapotranspiration and drainage studies; development of a crop evapotranspiration model; studies of nitrogen budgets in a maize-oat double crop system; energy analysis of farm systems; development of a mobile caravan for micrometeorological studies; measurement of soil temperatures under gorse burn.

HISTORY AND ACTIVITIES

Plant Physiology Division was established in 1962 with Dr K. J. Mitchell as Director. Its function is to study the way various features of New Zealand's climate, one of the country's major natural resources, regulate the development of plants and hence the financial returns from all types of crops. By employing staff trained in different disciplines, laboratory workers in physiology and biochemistry interact fruitfully with scientists in micrometeorology, crop physiology, and agronomy.

Much of the early Divisional effort was directed to the design and construction of the Climate Laboratory, opened in 1970. The Laboratory is run as a national research facility available to scientists from DSIR and other research institutions in New Zealand. It comprises 24 walk-in rooms in which temperature, humidity, day length, light intensity, and CO_2 levels are controlled. Special conditions (e.g. 10° frosts) can be provided on request.

Initial research effort centred on two complementary aspects of the influence of climate on crop yield—the control of plant development and the influence of the crop vegetation structure in the partitioning of radiant and advective energy. These interests have expanded to studies of how tropical cereals and grasses adapt to the relatively cooler New Zealand conditions and response to water stress. Microclimate studies and research have concentrated on the measurement of the evapotranspiration (total water loss from soil and vegetation in a particular area) of several crops and pastures.

The Division has examined the possible use of conserved forage crops such as maizes and sorghums for ruminant feeding, as an alternative to grazed pastures. Development of forage crops for this purpose is an important current research function, and a 20-ha research area is being developed for forage crop agronomy and evapotranspiration studies.

During the 1970s the Division has developed its genetic engineering research programme, with the aim of examining methods of by-passing the usual sexual cycle and accomplishing the transfer of genetic information between species, e.g., transferring selected bacterial genes into plant cells.

Industrial objectives include the improvement of yield and feed value of forage crops for ruminants, assessing water requirements of crops and pastures, and the application of specialist techniques in horticulture.

Science Information Division's new "super typewriter" (*above, foreground*) is much more versatile than standard machines. As well as ordinary typescript, it can produce "perfect" camera-ready copy for photo-litho printing without the need for expensive retyping. The material is typed on the modified keyboard and stored in magnetic tape cassettes for subsequent editing and correcting via the keyboard. The final, correct version can be printed out very quickly on command. More and more DSIR publications are being printed directly from typescript in this way, which is often quicker and cheaper than conventional metal typesetting (as used for *DSIR Research*).

SCIENCE INFORMATION DIVISION

Cubewell House, 16-17 Kent Terrace, Wellington
POSTAL ADDRESS: P.O. Box 9741, Wellington
TELEGRAMS: SIDSIR Wellington TELEPHONE: 858 939 Wellington
SUPERINTENDENT: G. J. Neale.

EDITORS
N.Z. Journal of Agricultural Research and
N.Z. Journal of Experimental Agriculture: M. J. Baker, BScAgric(Hons).
N.Z. Journal of Botany: Q. W. Ruscoe, PhD *Exon.*
N.Z. Journal of Geology and Geophysics: I. W. Mackenzie, BA, DipNZLS
N.Z. Journal of Marine and Freshwater Research: E. K. Saul, BSc.
N.Z. Journal of Science: J. G. Gregory, MA.
N.Z. Journal of Zoology: C. T. Duval, BSc.
Bulletins: D. J. Zwartz, BSc; A. P. W. Hodder, DPhil *Waik.*; D. A. Francis, BSc.

PHOTOGRAPHIC SECTION
Senior Photographer: J. J. Whalan.

INFORMATION SECTION
Scientific: K. S. Raxworthy, PhD *Canty.*
Agricultural: N. D. Scott (c/- DSIR, Palmerston North).
Technical and General: A. M. McCleary, DipJourn.
Head Office: W. Tait.

PUBLICATIONS SECTION
N. G. Stevens.

CARTOGRAPHIC SECTION
Chief Cartographer: F. J. Tindall.
Divisional Cartographers: B. W. Creed (Geology, Geophysics, Soil); T. Crayford (Oceanography); R. B. Phillips (General).

CENTRAL LIBRARY
Chief Librarian: P. Szentirmay, ANZLA.
Deputy Librarian: L. M. Milne, BA, DipNZLS.

STAFF at 31-3-76: 13 scientists and 57 supporting staff.

HISTORY AND ACTIVITIES

Proposals for development of a bureau of technical information were considered when DSIR was founded in 1926, but the Information Service of Head Office was not formed until 1944. The Service was designated Science Information Division (SID) in 1975. SID provides editorial, cartographic, library, photographic, and information assistance to all DSIR divisions and sections; and publication, library, and information facilities to other Government departments and the general public. It handles the printing, distribution, and sales of publications, as well as publicising the work of DSIR.

Editorial section

When DSIR was formed, it assumed responsibility for publication of *N.Z. Journal of Science and Technology,* which in 1958 was split into *N.Z. Journal of Agricultural Research, N.Z. Journal of Geology and Geophysics,* and *N.Z. Journal of Science*. From the last of these arose *N.Z. Journal of Botany* (1963), *N.Z. Journal of Marine and Freshwater Research* (1967), and *N.Z. Journal of Zoology* (1974). *N.Z. Journal of Experimental Agriculture* was started in 1973. All seven journals contain research articles by New Zealand authors or related to New Zealand's interests.

The first DSIR bulletins in 1927 and 1928 dealt with both agricultural and industrial investigations. Geological Survey Bulletins and Paleontological Bulletins had become well established several years previously. The DSIR Information Series and Soil Bureau Bulletins were first published in 1948, and Memoirs of N.Z. Oceanographic Institute began in 1955.

From 1946 to 1968 the *Industrial Bulletin* was published in collaboration with the Department of Industries and Commerce. Concepts of industrial liaison had changed by 1971, and *Industrial Development* was produced to show how Government departments could assist industry with research and economic advice. It was superseded in 1975 by *Productivity and Technology*, and DSIR's involvement has declined to providing occasional articles. Instead, SID is resuming production of DSIR industrial advisory leaflets.

Central Library

From 1926 the Library was a part of Head Office and later the Information Service. It contains a comprehensive selection of bibliographies, abstracts publications, and indexes, and provides a service for editors and authors. It also handles the purchasing of books and periodicals for the whole Department, keeps a Union Catalogue of DSIR holdings, and co-operates in an extensive interloan system.

Central Library specialises in science information publications. It has a large collection of publications from international organisations, e.g., UN agencies and OECD, and is the New Zealand agent for the Commonwealth Index of unpublished scientific translations. It co-operates with the National Committee for UNISIST, and it is the New Zealand agent for the US Current Awareness Services on Energy and Environmental Pollution and Control (CASE I and CASE II). The Library also co-operates with the National Library for SATIS, a scheme for giving information to industry.

Cartographic section

Maps dealing with geology, geophysics, oceanography, lakes and soils are published by DSIR, and the cartographic section prepares drawings and overlays for printing. All classes of draughting, including the preparation of line drawings and diagrams to illustrate scientific papers, but excluding mechanical design drawing, are provided.

Photographic section

This section undertakes general, technical, and experimental photography for Head Office and the Wellington branches. It also provides a ciné film unit for the Department and keeps a small collection of scientific and technical ciné films.

Information section

Information complementary to the formal scientific publications is disseminated through the daily and technical press and other news and information media. Inquiries are answered by reference to the literature or to branches of the Department and other organisations.

SCIENCE IN INDUSTRY UNIT

Charles Fergusson Building, Bowen Street, Wellington
POSTAL ADDRESS: DSIR, Private Bag, Wellington
TELEGRAMS: RESEARCH Wellington TELEPHONE: 729 979 Wellington
HEAD: F. E. Studt, BSc *Lond,* DIC, AMIMM.

Manufacturing in New Zealand had a production valued at $2 000 million and exports worth almost $200 million in the last financial year, the latter growing by 25% per annum over the last 5 years. Industrial research supporting and serving the manufacturing sector is undertaken in several divisions of DSIR, and the Science in Industry Unit, established at Head Office in 1971, helps co-ordinate this work. The Unit also maintains liaison with other Government departments and such organisations as the New Zealand Manufacturers' Federation.

ACTIVITIES

Science in Industry Unit aims to promote direct contact of DSIR with industry, and thus it has welcomed recent approaches by some of New Zealands' larger industrial complexes seeking meetings to discuss with DSIR aspects of their future research and development (R & D) programmes. Beneficial contact with industry also result from requests for assistance in assessing the R & D of some of the claimants that the Industrial Research and Development Grants Advisory Committee has increasingly made to the unit.

The Unit has a continuing involvement with the work of the NZ Energy Research and Development Committee, established in 1974 to give financial support to projects connected with the assessment, use, and conservation of New Zealand's indigenous energy resources. Because of this involvement, the Unit has gradually become the focus of energy matters within DSIR. In the field of geothermal energy, the Unit coordinates the research of several DSIR divisions. Geothermal resources offer the prospect of a relatively cheap source of heat at a time when the cost of oil, in particular, is climbing steeply. The more enterprising firms are beginning to look seriously at this resource, especially for process drying.

When New Zealand joined OECD, DSIR accepted responsibility for collecting information needed to assist the planning of future science activities. The data required cover the total resources in New Zealand devoted to research and experimental development. These data have ben compiled by the Science in Industry Unit, and the task has revealed some weaknesses in New Zealand science statistics. A statistics liaison officer has been nominated and a project initiated to improve the collection of the necessary data.

Liaison meetings between scientists from the industrial divisions of DSIR and the Department of Trade and Industry are actively fostered by the Unit and have proved valuable in bringing DSIR scientists in closer contact with the problems of industry. The unit is exploring ways of expanding these liaison contacts, such as including a wider range of DSIR officers and possibly by extending the arrangement to other Government departments.

SCIENTIFIC LIAISON OFFICE

New Zealand High Commission, New Zealand House, London SW1Y 4TQ
TELEGRAMS: DEPUTY London SW1 TELEX: 24368
SCIENTIFIC ATTACHE: C. M. Palmer, MAgrSc, DipEd.

New Zealand was the first Commonwealth country to set up a Scientific Liaison Office (SLO) in London in 1928.

Several prominent personalities have been associated with the London SLO. The first Liaison Officer was Mr Neville Wright, one of the three foundation professional staff employed by DSIR, who continued in the London post until 1943. Dr W. M. Hamilton, who later became Director-General of DSIR, was the first Assistant Scientific Liaison Officer from 1937 to 1941. Dr (later Sir Ernest) Marsden, first secretary of DSIR, was Senior Scientific Liaison Officer from 1947 until his retirement in 1954.

Recent re-organisation of the Office has enhanced integration of its activities within the overall responsibilities of the New Zealand High Commission in London, and the Office is now involved in the European scene rather than just the United Kingdom area. British membership of the EEC, establishment of New Zealand missions in other parts of Europe, membership by New Zealand of OECD, and increasing contact with Eastern European countries are areas of New Zealand's diplomatic activities in Europe to which the SLO contributes technical back-up and support.

Current New Zealand policy, executed in conjunction with staff based in Paris, is to establish closer contact with OECD scientific and technological staff and to become involved in a wider range of sub-committees and working groups. Close contact and attendance at appropriate meetings are also maintained with the International Energy Agency and the Union for the Protection of Plant Varieties. Representational duties also include the Executive Council of the Commonwealth Agricultural Bureaux (CAB), which is currently involved in a complete re-organisation of the Bureaux and Institutes to reduce costs and increase productivity.

The Scientific Attaché, seconded from DSIR, has a wide role in relation to New Zealand's scientific effort. This involves liaison on behalf of many New Zealand organisations, including Government departments, Universities, and the manufacturing and commercial sectors; facilitating the exchange of scientific information; and assistance with visits of scientific personnel between New Zealand, the United Kingdom, and other countries. The Office interviews applicants for scientific posts in New Zealand advertised in the United Kingdom and sends to appropriate employers information on scientific personnel interested in employment in New Zealand.

A major project, in collaboration with other Government departments, concerns oversight of the EEC Agricultural Seed Directives. DSIR, as the principal breeder of agricultural plants in New Zealand, has to liaise with EEC countries on variety testing, breeders' rights, and inclusion of species in national and EEC plant variety catalogues.

SOIL BUREAU

Eastern Hutt Road, Taita
POSTAL ADDRESS: Private Bag, Lower Hutt
TELEGRAMS: SOBUR, Taita TELEPHONE: 673 119 Wellington
DIRECTOR: R. B. Miller, MSc, Agr 1 (Sweden), FNZIC.

Soil Resources

Chief Pedologist: M. L. Leamy, MSc
Soil Correlation: J. D. Cowie, MSc
Soil Interpretation: G. E. Orbell, MSc

Chemistry and Data Centre

Chemistry: A. J. Metson, MSc, FNZIC, FNZIAS.
Analysis: L. C. Blakemore

Life Sciences

Soils and Nutrition: W. B. Healy, Ph.D Rutgers, FNZIAS, FNZIC.
Biochemistry: D. J. Ross, PhD Lond, Dip Bact Lond, FNZIC.
Biology: G. W. Yeates, PhD Cantuar

Physics and Physical Chemistry

Physical Chemistry: N. Wells, BSc Sp Lond.
Engineering: R. D. Northey, PhD Lond, DIC Lond.
Physics: R. J. Jackson, PhD Dunelm

Scientific Administration: R. J. Furkert, PhD *Well,* ARIC

SITE AND CLIMATE

Lat.: 41° 11' S. *Long.:* 174° 58' E.
Area: 88 ha. *Alt.:* 27.5–229 m
Soil Type: Taita hill soils from strongly weathered greywacke and Wingate soils from loessial drift.
Rainfall: 1316 mm per annum on 163 days; distribution slight winter peak.
Temperature: Mean max. 16.3°c; mean min. 8.6°c.
Days with ground frost: 29.
Hours of sunshine: 1789.

DISTRICT OFFICES

AUCKLAND:
Soil Survey,
120 Mt Albert Rd,
c/- Plant Diseases Division,
Private Bag
J. E. Cox, MA *Cantab*

HAMILTON:
Soil Survey,
Anglesea Bldg,
Cnr Collingwood and Anglesea Streets,
P.O. Box 1193
G. E. Orbell, MSc, MNZIAS

HAVELOCK NORTH:
Soil Survey,
DSIR,
Goddards Lane
E. Griffiths, BSc *Wales*

PALMERSTON NORTH
Soil Survey,
c/- Grasslands Division,
Private Bag
J. D. Cowie, MSc

ROTORUA:
Soil Survey,
c/- Forest Research Institute,
Private Bag
W. A. Pullar, DSc, AOSM

WELLINGTON:
Soil Bureau:
Eastern Hutt Road, Taita
Private Bag, Lower Hutt

LINCOLN:
Soil Survey,
c/- Crop Research Division,
Private Bag, Christchurch
T. H. Webb, MAgrSc

NELSON:
Soil Survey,
Cnr Milton and Halifax Sts,
Private Bag,
I. B. Campbell, MSc

DUNEDIN:
Soil Survey,
P.O. Bldg, Moray Place,
P.O. Box 5133.
D. M. Leslie, MSc

GORE:
Soil Survey,
c/- Grasslands Division,
Private Bag,
J. G. Bruce, MSc

STAFF at 31-3-76: 66 scientists, 28 science technicians, and 18 supporting staff.

The Bureau studies the soils of New Zealand, some Pacific Islands, and the Antarctic to provide fundamental data for land use and soil engineering. The studies include mapping and classification of soils according to their morphology and genesis; characterisation of each soil and its physical, chemical, and biological properties; gauging of each soil's potential capacity to change under changing conditions; communication of these findings and their implications to others working on related problems; interpretation of findings in national and regional land use planning.

Current projects

SOIL RESOURCES: Appraisal of soils for forestry development in Westland and Southland; appraisal of soils for irrigation development; soil surveys of counties, catchments and basins, urban areas, and other areas of special importance; determination of the soil resources of the Pacific Islands, specifically Cook Is and Tonga; soil group definition and regional studies; techniques and application of detailed soil surveys; revision of N.Z. genetic soil classification; evaluation of remote sensing and grid sampling techniques in soil surveying; compilation of soil unit sheets from computer printout; micromorphology of soil groups and soil sequences; soil structure changes under forestry; classification of land for irrigation, forestry and food production; soil productivity studies; evaluation of soils for different kinds of urban use; soil resource information — interpretation and application to indicative planning; nature of volcanic ash showers; determination of ages of volcanic surfaces, correlation of ash marker beds; loess as a soil parent material; studies of current loess deposition.

LIFE SCIENCES: Chemical properties of soil particle size fractions; Pauatahanui environmental investigation; effect of grass species on sulphur availability; field control of nematodes; effects of management on nematode populations in pastures; nematodes from New Zealand, Cook Is, Tongan soils; seasonal activity of arthropods in beech forest litter; beech forest studies on litter fauna, microflora, and comminution of organic matter by the detritus feeding beetle *Holotrochus;* taxonomy of *Holotrochus*; distribution of soil bacteria and protozoa in the New Zealand region; Massey effluent trial; ^{14}C measurement of organic matter turnover; use of isotopic methods to study cycling of sulphur; investigation of relationships between soil organic chemistry and environmental parameters in N.Z. soils; humic and non-humic substances, including carbohydrates, polyphenols, and organic phosphorus compounds in N.Z. soils; metabolism of soil organic matter; range of studies on a climosequence of soils in tussock grassland including activities of a number of enzymes of soil and plant fractions, chemistry and enzymology of litter decomposition, and respiratory activity, nitrogen mineralisation and protease activity; availability of nitrogen for plant growth in yellow-grey earths in tussock grasslands; influence of temperature on biochemical processes in soils; influence of ryegrass and clover plants on invertase and amylase activities in soil.

CHEMISTRY AND DATA CENTRE: Chemistry and fertility of Cook Islands and Tongan soils; element analysis of soils and plants as an index of soil fertility; use of chemical parameters in soil classification — a mathematical approach; reserves and availability of the major plant-nutrient elements Mg, K, and S in N.Z. soil groups; surface movement of the major plant nutrients on pasture slopes during rain storms; acid sulphate soils; effect of temperature on sulphur availability to ryegrass on soils from mica schist; forest tree nutrition and assessment of soil and site suitability for exotic forestry programmes; relationship of foliar and soil nutrient levels for a range of beech species; development of analytical methods for soil and plant constituents; variation in soil properties within a soil mapping unit; element distribution in deep loess profiles; N.Z. soil data base, computer-based soil classification file; data storage, collation, and correlation.

PHYSICS AND PHYSICAL CHEMISTRY: Moisture regimes of N.Z. and Cook Islands soils; aggregate stability of New Zealand soils under cropping; physical properties of pumice soils; unsaturated hydraulic conductivities of N.Z. soils; soil physical properties in relation to catchment hydrology; soil engineering problems associated with Mangaweka deviation of North Island Main Trunk Railway; gamma ray attenuation determination of continuous density profile of soil cores; urban development engineering soil surveys; study of runway failures at Wellington Airport; underground corrosion of steel, cement products, ceramic field tiles, rubbers and plastics; lime stabilisation of N.Z. soils; stem–flow and throughfall of rainwater on vegetation; geobiochemistry of rocks, soils and plants; reaction of fluoride irons with soils; element distribution in soil profiles; clay-organic matter interactions; waste water irrigation of soil columns; beneficial action of sewage sludge on plants; utilisation of Singapore sewage sludge; geochemistry of iron and manganese in soils; study of Fe in soils by Mössbauer spectroscopy; element and mineral distribution in aquatic communities; reactions of model organic compounds with topsoils; nature and origins of hydrous micas in soils.

HISTORY AND ACTIVITIES

The Soil Bureau had its origin in the Reconnaissance Survey of Central North Island of 1930 — a survey instituted by the Mineral Content of Pastures Committee of the Research Council as part of the investigations into bush sickness. The organisation was formally established on June 20, 1930, by the Prime Minister, the Rt Hon. G. W. Forbes, as the Soil Reconnaissance Division of the Geological Survey Branch of DSIR.

The Soil Reconnaissance was led by T. Rigg of the Cawthron Institute and carried out by L. I. Grange who had recently completed a geological survey of the Rotorua–Taupo area, and N. H. Taylor who had worked with H. T. Ferrar on soil surveys of irrigation areas in Central Otago. The survey related bush sickness to soils and went on to other successes. In 1933 it became the Soil Survey Section of DSIR under Dr Grange as Officer-in-Charge and in 1937, after considerable expansion of staff, became the Soil Survey Division with Dr Grange as Director.

During the depression the continuance of the Survey was often in doubt, and at times it only survived with the help of private firms and grants from the Empire Marketing Board. In one year a third of the total appropriation of £1200 came from private firms.

By the end of the thirties numerous valuable surveys had established the relevance of soils to agriculture and many demands were being made on the staff, now approaching 20 scientists and assistants. In 1939 most of the chemistry staff moved to 54 Molesworth Street, Wellington, from 71 Fairlie Terrace and from the Cawthron Institute in Nelson. In this year also it was decided to make a general soil survey of the North Island.

During the Second World War a wide range of new problems, pedological, chemical, biological, and physical were tackled, and staff expanded to meet the needs. In 1946 the Soil Survey was reorganised as the Soil Bureau with Divisions of Soil Survey, Chemistry, Biology, and Physics. Further expansion followed with soil scientists being consulted on many aspects of land use and making important contributions to national development and to science.

In 1952 Dr Grange returned to the Geological Survey as Director and N. H. Taylor became Director of Soil Bureau with J. K. Dixon, who had been associated with soil chemistry from the first days of the reconnaissance survey, as Assistant Director.

Over the next decade the work steadily increased and diversified, but unity was maintained by links to the New Zealand genetic soil classification. A general survey of the South Island completed the reconnaissance soil survey of New Zealand. A substation at Taita was developed from 1948 on, and in 1962 with the opening of a new laboratory it became the Bureau's headquarters. Field offices were, at that time, operating in 6 centres from Hamilton to Dunedin.

Dr Taylor retired and was succeeded by Dr Dixon as Director in 1963, by Dr M. Fieldes in 1966 and Dr R. B. Miller in 1973. The Bureau now has a staff of over 120 with 10 Scientific Sections at Taita and 9 Field Offices. The traditions of strong cross-disciplinary links within the Bureau, and close ties to users outside is maintained, and ensures that the Soil Bureau continues to produce work that is both of high scientific merit and of great practical value wherever land use problems occur.

TOBACCO RESEARCH STATION

Old Mill Road, Riwaka
POSTAL ADDRESS: R.D.3, Motueka
TELEGRAMS: TOBACCO RESEARCH Motueka TELEPHONE: 501 Motueka
SUPERINTENDENT: R. W. James, BSc *San.*

SITE AND CLIMATE

Lat.: 41° 6′ S. *Long.:* 172° 58′ E. *Height:* 8 m. *Soil:* Riwaka silt loam. *Rainfall:* 1372 mm. *Temperature:* Mean max. 29.1°C; mean min. 3.4°C; mean 12.3°C. *Days of ground frost:* 80.4. *Hours of sunshine:* 2485.

STAFF at 31-3-76: 3 scientists, 9 science technicians, and 4 supporting staff.

The Station, which was established in 1938, carries out research into all aspects of tobacco production in New Zealand from the seed to the point of manufacture.

Current Projects

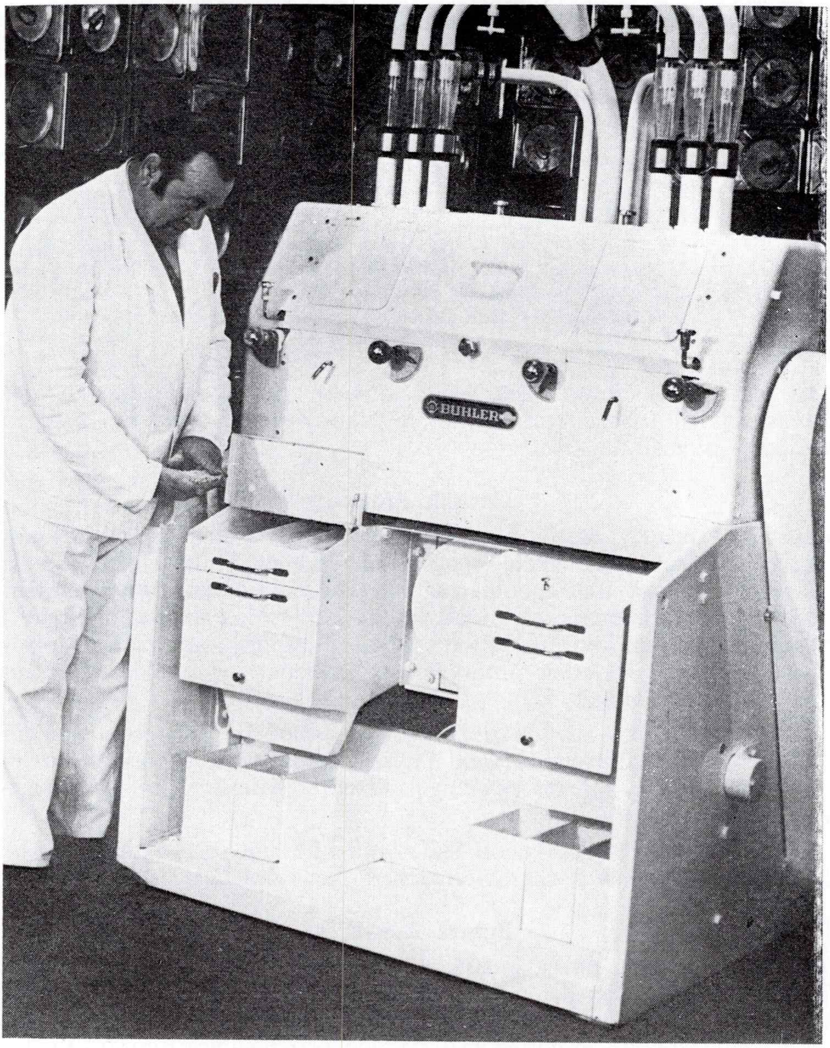
PLANT BREEDING: breeding and selection for resistance to verticillium wilt (a disease which infects tobacco only in New Zealand), black root rot, *Phytophthora,* blue mould, and tobacco mosaic virus; improvement of leaf quality characteristics, including physical and chemical attributes; plant introduction and evaluation; regional testing programme of introduced and bred varieties; production of nucleus seed stocks; treatment of all commercial seed.

AGRONOMY: effects of cultural and management practices on leaf quality, yield, and chemical and physical properties; chemical control of sucker growth, rate of ripening, and carbohydrate assimilation; air-cured tobacco types.

CHEMISTRY: investigation of leaf; soil nutrient relationships; basic chemical and physical characteristics of New Zealand leaf.

Future Activities

The domestic crop provides 50% of the tobacco used for manufacture in New Zealand. Further development of the growing industry depends on the production of high-quality leaf at a price which will compete with similar-quality imported leaf. Station activities are directed to this end by an Advisory Committee, comprising representatives of growers, manufacturers, and Government departments.



Wheat Research Institute uses a pilot-scale flourmill to assist millers through a test milling and baking service, and to test samples regularly from all mills for the New Zealand Wheat Board.

WHEAT RESEARCH INSTITUTE

197 Hereford Street, Christchurch
POSTAL ADDRESS: P.O. Box 1489, Christchurch
TELEGRAMS: WHEAT RESEARCH INSTITUTE Christchurch
TELEPHONE: 65 344 Christchurch (791 548 from mid 1976)
DIRECTOR: R. W. Cawley, MSc, FNZIC.

Basic Research: P. Meredith, PhD *Birm.*
Baking Technology: T. A. Mitchell, MSc.

STAFF at 31-3-76: 6 scientists, 7 science technicians, and 2 supporting staff.

The Institute undertakes research and other scientific work for the wheat growing, flour milling, and baking industries.

Research is concentrated on a few chosen subjects, but information and advice are available on many aspects of cereal technology: mechanical handling of grain and flour; storage; drying; entomology and mycology; flourmilling; grinding; sieving; particle-size analysis; bread, cake, and biscuit making; pasting and thickening; and nutritional aspects of cereals as human food and animal feed.

Flourmillers make extensive use of the Institute's test milling and baking services to help maintain uniform quality. Flour samples from all mills are regularly tested for the New Zealand Wheat Board.

Current Projects

BASIC RESEARCH: studies of the developing cereal grain, including anatomical and chemical changes in grain development; weight gain; starch granule development; the enzymes involved in starch synthesis; and, in collaboration with Botany Department, Canterbury University, light and electron microscopy of grain structure.

BAKING TECHNOLOGY: development of a method of incorporating milk powder in bread without damaging loaf volume and crumb texture.

HISTORY AND ACTIVITIES

Wheat Research Institute (WRI) was established in 1929. It originally consisted of a cereal laboratory in Christchurch and a wheat-breeding section at Lincoln, but in 1950 wheat breeding was transferred to Crop Research Division. Breeders' material is still tested for milling and baking quality at the Institute. Finance comes from a Government grant and from a levy on the flourmilling and baking industries, and WRI has been involved in most of the changes in these industries since the 1930s.

When the header harvester superseded reaping, binding, stooking, and thrashing, WRI was particularly concerned with the lower grain moisture content necessary for direct heading and provided a moisture testing service for many years.

Progressive increase in the size of bakeries and mechanisation, including travelling ovens through which the bread is conveyed continuously, involved the Institute in devising new ways of controlling the baking process to suit the plant.

Public preference is for bread baked in an atmosphere rich in water vapour. WRI developed an instrument for measuring steam concentration and was able to design ovens which retained the steam given off by bread so that they became self steaming, with consequent large savings in capital and running costs. Most ovens in New Zealand and Australia incorporate these findings.

Since 1964 the Institute, at the request of the Flour Millers' Association, has provided a wheat testing service which supplies flourmillers with information on the baking quality of individual parcels of wheat at time of purchase.

Bulk harvesting of wheat replaced bagging in the 1960s. WRI was involved in problems of moisture measurement methods, farm driers, and insects. Bagged wheat could be kept separate at the mill, but bulk wheat must be tipped in large bins with other wheat. Knowledge of the quality of each parcel of wheat, provided by the Institute's testing service, is essential before the wheat can be tipped.

The Mechanical Dough Development Process eliminates the traditional fermentation stage in bread-making by energetically mixing dough in specially designed mixers. This process saves both time and space and gives a more attractive loaf. WRI made an intensive study of the process and its application under New Zealand conditions, and it is now used to make about 70% of New Zealand's bread.

RESEARCH ASSOCIATIONS

BUILDING RESEARCH ASSOCIATION OF N.Z. (Inc.)

42 Vivian Street, Wellington
POSTAL ADDRESS: P.O. Boxes 9446 and 9375, Wellington
TELEGRAMS: BRANZ Wellington TELEPHONE: 851 479 Wellington
DIRECTOR: P. K. Foster, PhD *Lond*, DIC, FNZIC.

Information Services: L. T. Bowen, ANZIA, ARIBA.
Components Research: H. A. Trethowen, BE Mech, MNZIE, MIMechE, MIHVE.
Materials Research and Appraisal: I. C. Hope, BSc, MInstF.
Management Research:
Fire Research: D. Bastings, BE, MNZIE.

REGIONAL ADVISORY OFFICES

AUCKLAND: Auckland Building Display and Development Centre, Wellesley St. P.O. Box 5499. Telephone: 30 976, 374 780.

WELLINGTON: Building Research Association, 42 Vivian Street. P.O. Box 9375, 9446. Telephone: 851 479.

CHRISTCHURCH: Christchurch Building Display and Information Centre, 211 Cashel Street. P.O. Box 496. Telephone: 51 201.

DUNEDIN: Otago Building Centre, Manse Street. P.O. Box 1219. Telephone: 78 414.

STAFF at 31-3-76: 31 scientists, 8 science technicians, and 10 supporting staff.

The Building Research Association promotes and conducts research and development in the building industry.

It provides the interface between the building industry and the knowledge it needs to meet its clients' technical requirements and through its research satisfies the particular technological needs not elsewhere being satisfied. The Association's work is divided into four research areas, and there are also Appraisal and Information Services.

Current Projects

COMPONENTS RESEARCH: testing and development work on sound transmission of a selection of basic ceiling types; survey of sound absorbers; preparation of a guide to information on reflective insulants; continuing work on development of moisture design methods; also industry testing of thermal conductance of walls.

MANAGEMENT RESEARCH: continuing work on labour recruitment and turnover of painters and electricians; research on causes of crane accidents and costs of accidents; continuing work on tendering procedures; and the completion of work on metrication.

FIRE RESEARCH: operational studies of fires; research on earthquakes and fires; construction of large-scale fire test facilities; continued fire testing for industry.

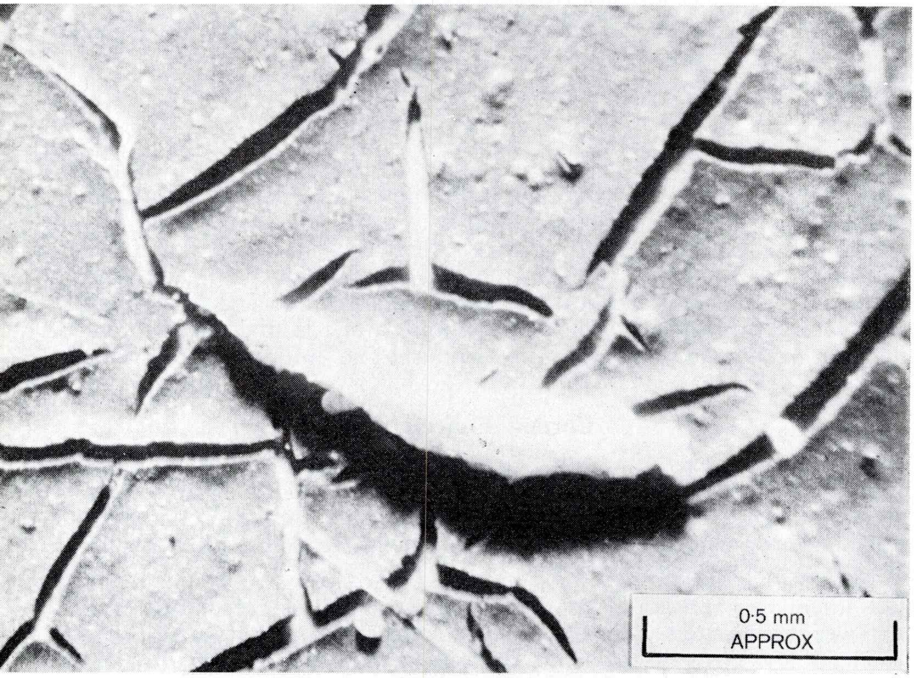
MATERIALS RESEARCH: nail testing for timber joints; wall lining distortion; meat- and dairy-factory floors and walls; exposure testing, including testing of roof paints, plastic vertical boarding, and particle board; studies of concrete finishes.

APPRAISAL DIVISION: appraisal of building products by comparison of properties with desirable performance criteria and issuing of certificates for satisfactory products.

INFORMATION: development and operation of keyword retrieval system for information required by the building industry.

ACTIVITIES

The Association formed in 1970, is financed by a Building Research Levy and contributions from Government, and is controlled by a Board of Management from the industry. Over the next few years all divisions will be accommodated at the Judgeford site north of Wellington.



An important feature of many building products is their durability under natural weathering. Paints are tested in weather exposure trials; the photo shows a low-power magnification of severe cracking and white rust on a paint film after 6 months' exposure.

N.Z. COAL RESEARCH ASSOCIATION (Inc.)

DSIR No. 2 Building Gracefield Road, Lower Hutt
POSTAL ADDRESS: P.O. Box 3041, Wellington
TELEGRAMS: COAL Wellington TELEPHONE: 662 289 Wellington
DIRECTOR: P. A. Toynbee, BSc, DipIndChem, MIChemE, MInstF, MNZIE.
EXECUTIVE OFFICER: L. D. O'Connor.

STAFF at 31-3-76: 7 scientists, 19 science technicians, and 3 supporting staff.

COAL ADVISORY OFFICES
Auckland, Hamilton, Palmerston North, Christchurch, Dunedin

The Association's activities are directed to the promotion of existing and new coal markets by: improving the quality of coal delivered to the user; ensuring greater cleanliness, convenience, and efficiency in the handling and use of coal; maintaining an analytical service for the coal industry; and providing a national advisory service to coal users.

Current Projects

COAL ANALYSIS: analysis of core samples from drilling programmes, geological and prospecting samples, and samples of mine production and industrial coal.

FUNDAMENTAL STUDIES: basic work directed to a better understanding of the properties of New Zealand coals, which often differ from those found overseas.

APPLIANCE DEVELOPMENT: design of domestic, commercial and industrial coal-burning appliances to suit New Zealand coals. This work is determined largely by: existing gaps in the availability of coal-fired appliances; the need for a clean environment; the need to use coal to the maximum advantage to the national economy; and the need for a fuel to meet impending shortages of fuel oil and electricity.

MATERIALS HANDLING: development and installation of modern industrial coal-handling methods, especially of enclosed transport systems from enclosed bunkers, for automatic and dust-free operation; design of bunkers.

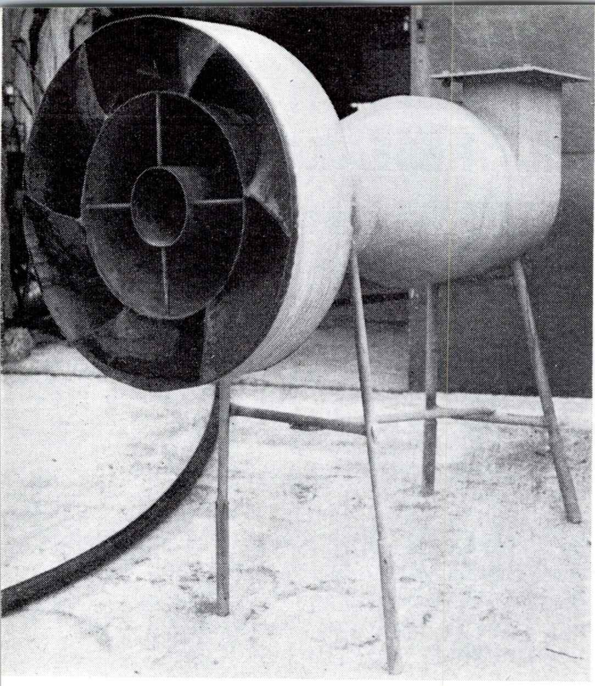
PULVERISED FUEL: application of pulverised fuel to the firing of industrial boilers and to industrial drying processes.

COAL PREPARATION: consideration of coal-preparation plant for use in New Zealand conditions; improving methods of up-grading slack coal; drying of coal.

EXTENSION SERVICE: provision of a nation-wide advisory service to coal users, especially industrial consumers, by fuel technologists in the field.

HISTORY AND ACTIVITIES

The NZ Coal Research Association was formed in 1967 by the amalgamation of Chemistry Division's chemical and engineering activities in coal research and the Coal Advisory Service Association. A major res-



There is growing interest in the firing of industrial boilers with pulverised fuel, and Coal Research Association has developed an improved design of burner. Shown here is a prototype low-cost burner made of mild steel, in which the intensity and shortness of the flame are improved by the swirling of the pulverised fuel and the air in which it burns. *Photo: National Publicity Studios*

ponsibility of the new Association was to increase burning of coal by making the fuel cleaner and more convenient to use. Considerable progress has ben made, and for home heating there are now available space heaters and automatic boilers which are acceptable to Clean Air Authorities and which offer a high standard of convenience and cleanliness. Similar important advances have been made in commercial heating and industrial boilers, especially in pulverised-fuel firing which is so well suited to New Zealand coals and conditions.

Another early aim of the Association was to improve coal storage and handling in factories. Developments include the design of storage systems with enclosed bunkers, allowing coal to be fed automatically and without manual effort to the boilers. The Association has also introduced improved methods of coal transport, e.g., completely enclosed, dust-free, pneumatic systems.

Achievements in appliance development have resulted from an increased appreciation of New Zealand's unusual sub-bituminous coals, notably of their high reactivity. Although combustion equipment is now being designed to take full advantage of this property, it is not yet known why these coals are so reactive. The Association has undertaken a programme of fundamental research, funded by the NZ Energy Research and Development Committee, to study this feature of New Zealand's coal.

N.Z. CONCRETE RESEARCH ASSOCIATION

13 Wall Place, Porirua
POSTAL ADDRESS: P.O. Box 50156, Porirua
TELEGRAMS: CONSEARCH Porirua TELEPHONE: 8379 Tawa
DIRECTOR: J. H. Garside, PhD *Lond*, ARIC.

The Association is concerned with studying concrete as a material, i.e., the characteristics of its constituents and their influence on its properties and performance. In addition the Association undertakes specific investigations which provide cement-using and other organisations with opportunities to participate in research work on a co-operative basis.

To help train people employed in the concrete and related industries, the Association periodically arranges courses and seminars designed to supplement existing training opportunities.

Current Projects

CONCRETE AGGREGATES: determination of the characteristics of aggregates in relation to their usefulness in concrete making, to enable the development of selective specification of aggregates.

SHRINKAGE-COMPENSATED CONCRETE: effect of expansive admixture content on compressive strength, dimensional movement, workability, and durability in relation to some specific construction projects where shrinkage compensation is specified; in-service monitoring of performance.

CONCRETE MASONRY: development of valid testing procedures for structural masonry; investigation of factors affecting masonry performance.

CONCRETE EARLY STRENGTH: factors affecting early strength of concrete in relation to pre-cast concrete production practices.

LIGHT-WEIGHT CONCRETE: use of pumice and scoria as light-weight concrete aggregaes, with emphasis on some specific end-uses; durability of reinforced pumice concrete including composite steel and fibre reinforcement.

CEMENT STABILISATION: influence of cement stabilisation on the engineering properties of soils, with the aim of its wider use in road construction where economic advantage can be demonstrated.

CONCRETE TESTING METHODS: appraisal of testing methods, in particular compression testing machine performance; development of new procedures, including accelerated tests and non-destructive methods.

HISTORY AND ACTIVITIES

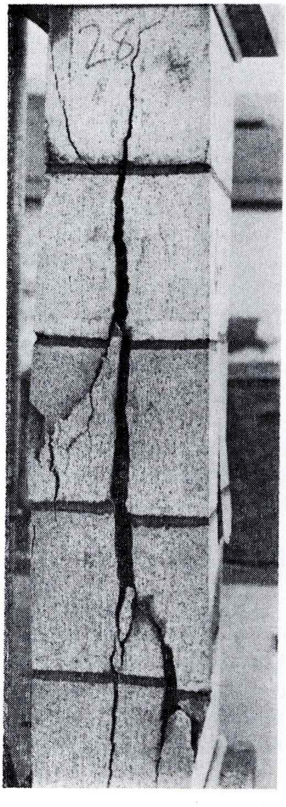
In 1948 the New Zealand cement manufacturers set up the N.Z. Portland Cement Association for the purposes of improving and extending the uses of cement by technical development. The Association became well known for its contributions to the technical knowledge of the industry through its publications, participation in formulation of standards, technical servicing, consultative work, educational courses, sponsoring of research and other activities.

In line with experience and developments in other countries the N.Z. Portland Cement Association established its own research laboratory facilities in 1969 at Porirua. The work done at Porirua was designed to have a beneficial effect over a broad range of the concrete industry and yet was financed without the support of the concrete industry itself.

As a result of negotiations between the N.Z. Portland Cement Association, on behalf of the cement manufacturers, and Government the N.Z. Concrete Research Association was established in 1972 in which it was envisaged that, in time, the whole of the cement and concrete industry of New Zealand would participate. At present, the cement manufacturers of New Zealand still carry the full financial responsibility of the industry contribution to the Research Association but there are encouraging signs that cement user industries are moving towards greater financial participation. This is evidenced by increasing cement user sponsored research that has been carried out in recent years.

The Research Association maintains close co-operation with the N.Z. Portland Cement Association, Ministry of Works and Development, DSIR and other Research Associations and seeks to maximise the combined research resources of these organisations where possible. A number of co-operative investigations have been initiated and representatives of these organisations, together with those from various sections of the concrete industry, play an important part in advising the Research Association Board via their membership of its Technical Advisory Committee.

In the field of education the Association is very active in providing opportunities for study at both technician and professional level via courses, seminars and conferences.



The Concrete Research Association is investigating how characteristics of the various constituents of concrete influence its properties as part of a review of the New Zealand Standard for masonry construction. Shown here is a five-unit masonry prism which has failed during an axial compression test.

N.Z. DAIRY RESEARCH INSTITUTE

Fitzherbert West, Palmerston North
POSTAL ADDRESS: Private Bag, Palmerston North
TELEGRAMS: DAISEARCH Palmerston North TELEPHONE: 74 129 Palmerston North

DIRECTOR: W. A. McGillivray, JP, PhD *NZ*, DSc *Massey*, FRSNZ, FNZIC.

ASSISTANT DIRECTOR: P. S. Robertson, PhD *Rdg*, FNZIC.

Fundamental Research: R. C. Lawrence, PhD *Massey*, Dip. Ed. *Cantab.*, FNZIC.

Applied Research: W. B. Sanderson, BAgrSc. (Dairy Tech.) *NZ*, PhD *Wis*.

STAFF at 31-3-76: 59 scientists, 51 science technicians, and 32 supporting staff.

The Institute is the principal research organisation serving the New Zealand dairy industry. Its research programmes include investigating methods for the improvement of traditional dairy products such as butter, cheese, milk powder and casein to satisfy continued demands for improved quality; methods for conserving energy within the industry and decreasing manufacturing costs; mechanisation of manufacturing processes; and the development of new dairy products and new uses for conventional dairy products. Emphasis is placed on the maximum possible recovery of all milk proteins and their production and use as foods or food additives.

Most of the work at the Institute falls into one of two broad categories: applied investigations on process and product development (of new products and variations of traditional products); and a supporting category of fundamental research designed to increase the knowledge of the basic components of milk, and the changes that occur during the processing of milk into dairy products.

Many of the markets outside the United Kingdom continue to require non-Cheddar types of cheese, and research into the manufacture of such varieties as Gouda, Mozzarella, Fetta, Domiati and Camembert continues, together with a continuing programme on the mechanised processing of both Cheddar and non-Cheddar varieties.

The development of the solvent crystallisation process for fractionation of milkfat has resulted in the establishment of a pilot-scale plant for this. The production of specialty butters and other products for use in the bakery and confectionery trades is being pursued.

Increase in the market requirements for skim milk and whole milk powders has resulted in the need for greater production and quality control. The joint research programme involving PEL, Massey University, IBM, New Zealand Dairy Board and the Institute, aimed at the automatic computerised control of evaporator and spray drier plants used in the production of milk powders, is continuing.

The use of caseins and related protein products as tailor-made components in various foods continues to receive attention, and in response to customer enquiries a variety of products and processes is being developed to use the characteristic functions and properties of these protein components. The nutritional evaluation studies being carried out in conjunction with the development of these products are providing a wide range of valuable information on the nutritive properties of New Zealand dairy products.

Costs of effluent disposal and treatment are of increasing importance to dairy companies. To gain a better appreciation of dairy company discharges, efforts are being concentrated on monitoring effluent from various product plants. From the results the nature and minimum quantity of effluent inherent in a particular processing method can be determined and suitable treatment methods devised. To assist in this work a mobile laboratory provides monitoring and test work facilities in the field.

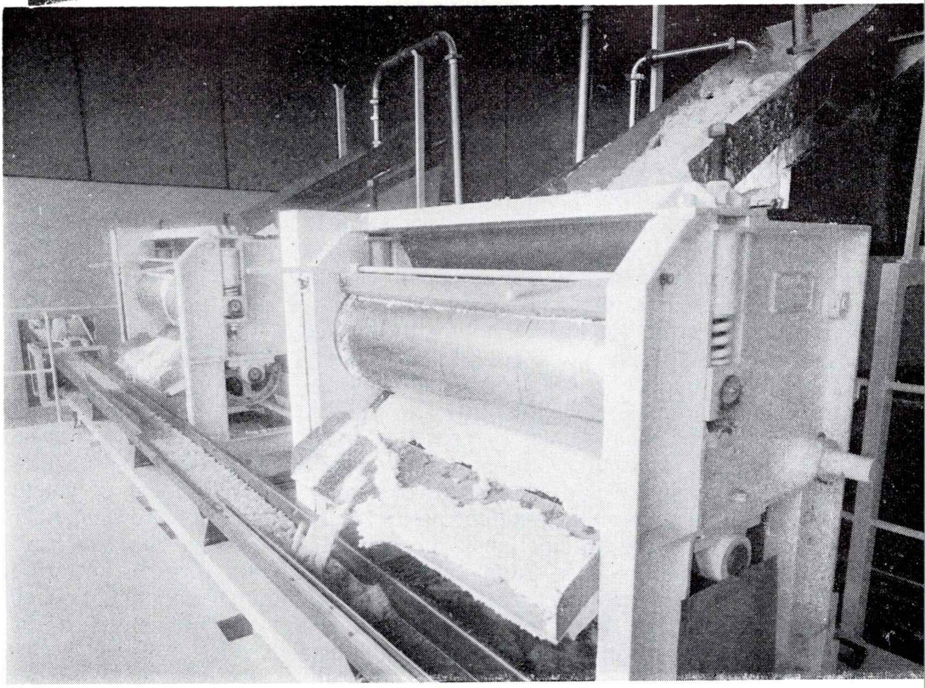
Continuing assistance is provided by the Engineering Services Section of the Institute in building construction and design, ventilation, energy conservation and fuel economy. This Section also advises dairy companies on the selection, commissioning and test acceptance of new equipment.

A wide variety of technical literature in the Institute library is available to and used by food industry personnel. The Institute issues a comprehensive Annual Report, a quarterly news circular, and proceedings of specialist conferences and symposia.

HISTORY AND ACTIVITIES

Although the beginnings of our dairy industry as an export industry go back to the advent of refrigeration in ocean-going ships in the 1880s, there was little application of science in the industry before the establishment of the Dairy Research Institute in 1927 as the first Research Association and a branch of the new Department of Scientific and Industrial Research. The rapid expansion of dairy farming after the First World War and the need for improvement in the quality of butter and cheese, which had to compete in the markets of the Northern Hemisphere, led to the establishment of the Dairy Research Institute. This was part of Sir Frank Heath's recommendation to the New Zealand Government in 1926, concerning the organisation of science and the creation of a Department of Scientific and Industrial Research.

Representatives of the Research Council, Dairy Board, Department of Agriculture, and New Zealand University College of Agriculture (later Massey Agricultural College and now Massey University) met in April 1927 and decided that a dairy research organisation should be established at the newly-created College of Agriculture. They also agreed that the Government and Dairy Board should provide, equally, the annual budget (estimated at £6000), and that the Government should bear the cost of establishment. In accordance with these arrangements, the Research Council appointed a Dairy Research Management Committee which named the new organisation the Dairy Research Institute (N.Z.) and proceeded rapidly with its setting-up. Before the



Casein passing through a drying press at a co-operative dairy factory. In a hungry world, as demand for food proteins has grown, research on casein and related products has been directed to their final use in various food systems, rather than for industrial purposes.

end of 1927 Professor W. Riddet became Director and Dr F. H. McDowall was appointed Chemist. Early in 1928 Dr H. R. Whitehead was appointed Bacteriologist.

These three plus a handful of other foundation staff did a remarkable job in convincing a somewhat sceptical dairy industry that science and technology could make really worthwhile contributions to the well-being of dairying. The move from temporary accommodation into the main science building at the College in 1931 permitted an increase in activities, but coincided with the onset of the depression. Fortunately the work of the Institute was already recognised, and the Empire Marketing Board (United Kingdom) made a grant of £2000 per annum for four years, plus a capital grant of £500 for the study of fundamental factors affecting cheese quality. The Dairy Board guaranteed a contribution of £7000 and eventually, when the depression intensified, also met a short-fall in the State quota. At about this time the first steps were taken towards making the Institute independent of the Public Service, although, with the intervention of the war, this did not occur until 1947 when the Institute was incorporated under what is now the Charitable Trust Act, 1957. The Institute was re-named the New Zealand Dairy Research Institute in 1966, and the present Board comprises representatives of the Dairy Board (4), Minister of Science (2), Minister of Agriculture and Fisheries (1), Dairy Factory Managers' Association (1), Massey University (1), three ex-officio members, and up to four co-opted members.

By the early 1960s the staff of the Institute numbered 50. At this time the Board, recognising the need for rapid diversification of products and markets in anticipation of the United Kingdom joining the European Economic Community, agreed to a major increase in staff and the enlargement of the laboratory accommodation and pilot-scale manufacturing facilities. In succession to Prof. Riddet, Dr Whitehead, and Dr McDowall, Dr W. A. McGillivray was appointed Director in 1965. He was responsible for staff expansion, the 1966 move into the present laboratory and office building and later, in 1968, for the transfer from the old Dairy Factory to the much larger Processing Hall. The staff establishment is now 159 and the industry's contribution to the $1.4 m budget is about 60 per cent, with DSIR providing most of the balance. To date the Institute has published some 700 papers plus numerous technical notes, proceedings of conferences, seminars, symposia, etc. It is thus impossible to review its achievements in a few words. They include matters as diverse as the development of single strain cultures for cheesemaking, major contributions to knowledge on bacteriophage–host interactions, mechanisation of the cheesemaking process, techniques for making anhydrous milkfat (a form of butterfat which will keep for some years without refrigeration), deodorisation of cream, design of dairy factories, and development of special dairy products such as Blue Vein cheese and milk biscuits.

As the largest, and oldest established Research Association in New Zealand, the Institute has served as the model for other Associations, both within New Zealand and overseas.

N.Z. FERTILISER MANUFACTURERS' RESEARCH ASSOCIATION (Inc.)

61 Otara Road, Otara, Auckland
POSTAL ADDRESS: P.O. Box 23 637, Papatoetoe East TELEPHONE: POP 47 184 Auckland
DIRECTOR: J. Rogers, PhD *Cantab*, FNZIC, MAIME, MAIMM.

Chief Chemist: P. J. Gallaher, BSc, FNZIC.
Agronomy: F. B. Muller, MS *R.I.*
Physical Chemistry: M. S. White, PhD *Tas*, MNZIC.
Chemical Engineering: D. L. Thomas, BSc (Hons) *Birm*, CE, MIChE.
Librarian: G. W. Rutter, NZLA Cert.

STAFF at 31-3-76: 10 scientists, 8 science technicians, and 4 supporting staff.

SITE AND CLIMATE

Lat.: 36° 57' S *Long.:* 174° 52' E
Area: 3 ha *Alt.:* 12 m
Soil types: Papatoetoe and Flatbush silt loams — brown granular and meadow soils derived from volcanic ash.
Rainfall: 1220 mm per annum on 173 days, fairly even distribution, occasional dry spells in summer.
Temperature: Mean daily max. 18.7°*C*; min. 10°*C*.
Days with ground frost: 40.

The Association's research programme emphasises the chemistry of superphosphate manufacture together with some agronomic studies, in field and glasshouse, of new and modified types of fertiliser, particularly phosphates. More investigations are being conducted under practical conditions in works of member companies. In planning and assessing the progress of research projects, close liaison is maintained with supporting companies. Government departments, universities, the British Phosphate Commissioners, and others concerned with the supply of raw materials, and the manufacture, efficient distribution, and use of fertilisers.

Current projects

Research on the gases, solids, and liquids produced during the manufacture of single superphosphate is being extended to a wide variety of phosphate rocks and their blends. Partly because of a serious decline in fertiliser sales, teams drawn from the fertiliser chemistry, physical chemistry, and chemical engineering sections were able to conduct many trials in the works of member companies. The relative importance of rock fineness, constancy of rock proportions or blend, sulphuric acid strength, and den retention time were tested. The first two were most important in operational control of the production of superphosphate from blends of Nauru and Christmas Island phosphates.

Agronomic studies of the effectiveness of water-insoluble phosphates for pasture plants were continued in field and pot trials with calcined Christmas Island phosphates and sedimentary and igneous apatites. Soluble and insoluble copper compounds changed the copper content of clover little, although available and total copper rose in the soils tested. Another trace element investigation, prompted by shortages of the water-soluble borates usually mixed with phosphate fertilisers, was the ability of borate minerals to supply the boron needs of turnips.

HISTORY AND ACTIVITIES

In 1947 all the superphosphate manufacturers in New Zealand agreed to constitute FMRA. The Association's laboratories were established at the Otara Research Station in 1950 with Dr (now Sir) Malcolm Burns as Director. The original public and private shareholder member companies were joined by the three former co-operatives which have begun fertiliser production since 1954.

Although initially the manufacturing plants were "out of bounds" to research staff this policy changed after FMRA proved scientifically and conclusively that fertiliser works were not the cause of blackening painted houses around the Manukau Harbour. Currently 70% of the research effort is devoted to fertiliser manufacture and the rest to its use.

Technical Conferences inaugurated by FMRA in 1957 provided a focus for a growing co-operation on technical matters. Since 1966 the research effort has been greatly expanded to the present budget $254 000. FMRA's work attracted a record attendance of 200 at its 15th Technical Conference in November 1975 including the 12 delegates from Chile, India, Indonesia, Malawi, Mauritius, the Philippines, Sri Lanka, Tanzania, and UNIDO, to a New Zealand-UNIDO Fertiliser Production Technology Workshop; and 12 Australians.

RESEARCH INSTITUTE OF LAUNDERERS, DRYCLEANERS, AND DYERS (Inc.)

DSIR No. 2 Building, Gracefield, Lower Hutt
POSTAL ADDRESS: Private Bag, Lower Hutt
TELEGRAMS: RILDAD Lower Hutt TELEPHONE: 666 919 Wellington
DIRECTOR: N. S. Whittall, MSc.

STAFF at 31-3-76: 5 scientists and 1 supporting staff.

The Research Institute of Launderers, Drycleaners, and Dyers (RILDAD) was founded as a research association in 1947, but the first director, N. S. Whittall, was not appointed until 1958. Initially, laboratory work was carried out by Dominion Laboratory. The aims of the Institute were to advise members, particularly those involved in the laundry and drycleaning industries, on new developments in textiles, machinery, and processes.

Although these aims are still pursued, RILDAD has expanded its field of activities, and in 1958 membership was extended to all companies engaged in the textile and garment trades. Such companies are classed as associate members.

Research work at the Institute is mainly "ad hoc" and covers a wide range of problems occurring with the use of new fibres and new methods of fabric and garment manufacture. Rapid changes in these fields account for the present negotiations to expand the Institute's facilities so it can offer a wider range of testing and development services to fabric and garment manufacturers.

The Institute also offers members a work study and planning service to ensure maximum use of equipment and manpower, particularly in hospital laundries where service requirements are constantly changing.

MAIN INVESTIGATIONS

The recent advance of machinery technology has changed considerably the laundry and drycleaning industry. Machines are now larger and are often automatic. Much of the Institute's laboratory work has been to ensure that such machines use the most efficient cleaning procedures as an inefficient process can lead to many lost hours of machinery production capacity.

In the clothing trade many new techniques have been or are being developed, e.g., permanent pressing of fabrics, multiple fabric bonding, and fused-on interlinings. Technical evaluation of a process and its finished products is necessary, and laboratory work has frequently enabled manufacturers to change techniques and achieve a more serviceable product.

Investigational work is also being carried out on the product performance of garments and fabrics. For example, fabrics considered suitable for parkas are being subjected to a range of tests which correlate testing conditions and performance with potential product use. Commercial furnishing fabrics are subjected to weathering and washing tests, to evaluate the effect of sunlight and repeated washing and drycleaning.

N.Z. LEATHER AND SHOE RESEARCH ASSOCIATION (Inc.)

Corner of Dairy Farm and Poultry Farm Roads, Palmerston North
POSTAL ADDRESS: Private Bag, Palmerston North
TELEGRAMS: LASRA Palmerston North TELEPHONE: 82 108 Palmerston North
DIRECTOR: G. W. Vivian, PhD *Leeds.*

STAFF at 31-3-76: 6 scientists, 7 science technicians, and 3 supporting staff.

The Association (LASRA) is the central research organisation serving the fellmongering, hide-curing, tanning, and footwear-manufacturing industries. Research work aimed to improve production methods and products is planned with the co-operation of technical advisory committees comprising LASRA members.

The Association disseminates results of its own and overseas research in regular reports and at conferences; tests and advises on the suitability of all types of components for footwear manufacturing; and reports on approximately 500 consumer footwear complaints annually.

Current Projects

HIDES AND CALFSKINS: short-term preservation; cause of the calfskin grain defect, mycotic dermatitis; evaluation of bactericides.

SHEEPSKINS AND LAMBSKINS: rapid processing so wool can be pulled 2 hours after painting; heating in stacks of painted skins; liming pulled lambskins for the production of smooth grain pelts; fungicides and mould growth on pickled pelts; drum-salting woolskins; packaging pelts; characteristics and treatment of fellmongery effluent.

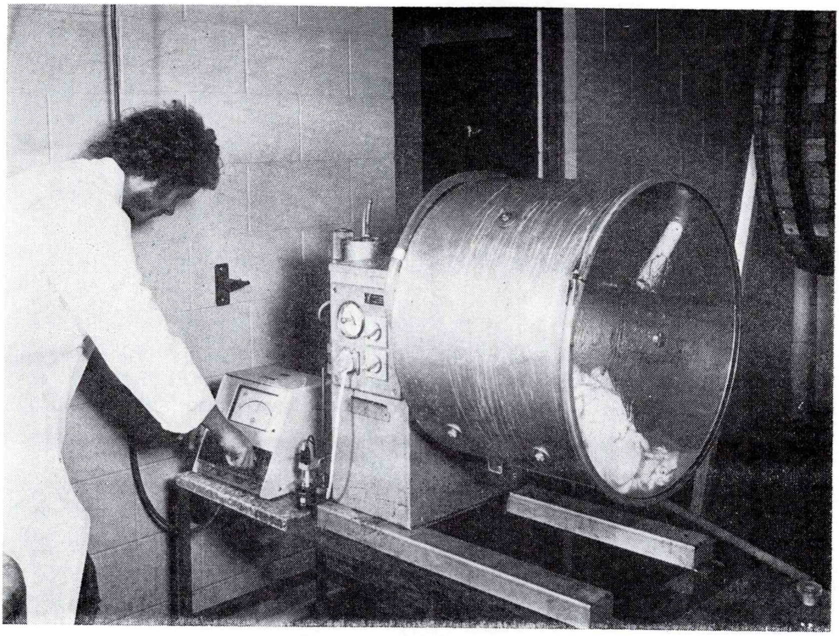
LEATHER: non-sulphide depilatories; effect of cattle and sheep breed on quality of leather made from hides and skins; processing green hides to wet blue leather in 24 hours; effect of surfactants on distribution of tanning agents and grease; drying of leathers; physical properties of upper leathers and finishes; wash and rub-fastness of suede clothing leathers; characteristics and treatment of tannery effluents.

FOOTWEAR: slip resistance and durability of soling materials; hot melt cements; lining materials; sampling and quality control.

HISTORY AND ACTIVITIES

The Leather Research Association was established by the tanning industry in 1928 as a section of DSIR. When membership was offered to the footwear industry in 1936, it became known as the Leather and Shoe Research Association. Membership was further expanded in 1949 when LASRA was incorporated as an independent research body to include the fellmongering and hide-curing industries.

Initially, the Association worked to introduce science-based methods of controlling tannery processing and to advise on setting-up of works laboratories. Research was concerned with the effect of pre-tanning treatments, tanning, and post-tanning treatments on the chemical characteristics of leathers. More recently, LASRA has been investigating



An experimental version of a tannery processing vessel enabling visual examination of skins during processing. The process liquor can be withdrawn and reintroduced, and thus monitored and adjusted, while sequence of treatment of the skins is maintained.

the effect of tannery processing on those physical properties of leathers important to leather-using industries.

Studies at LASRA have provided significant economic benefits to New Zealand. When the fellmongering and hide-curing industries applied research results to wool removal, pickling of pelts, and curing of hides and calfskins, the consequent improvements ensured that the products reached overseas tanneries in sound condition. The highlight of the Association's work is probably the discovery, based on laboratory work and backed up by large-scale works trials, that the incorporation of boric acid in salt used to cure calfskins eliminated a defect known as "hard spot".

N.Z. LOGGING INDUSTRY RESEARCH ASSOCIATION

POSTAL ADDRESS: P.O. Box 147, Rotorua.
DIRECTOR: J. J. K. Spiers, BSc, MF *Brit. Columbia*

The Association, incorporated in 1974, promotes, co-ordinates, supervises, and conducts research and scientific work in connection with the logging industry. Logging is defined by the Association as the industry engaged in harvesting trees, i.e., felling, extracting from the forest, semi-processing, and transporting wood to ship-side or to a place for processing. This definition includes all ancillary and extension services.

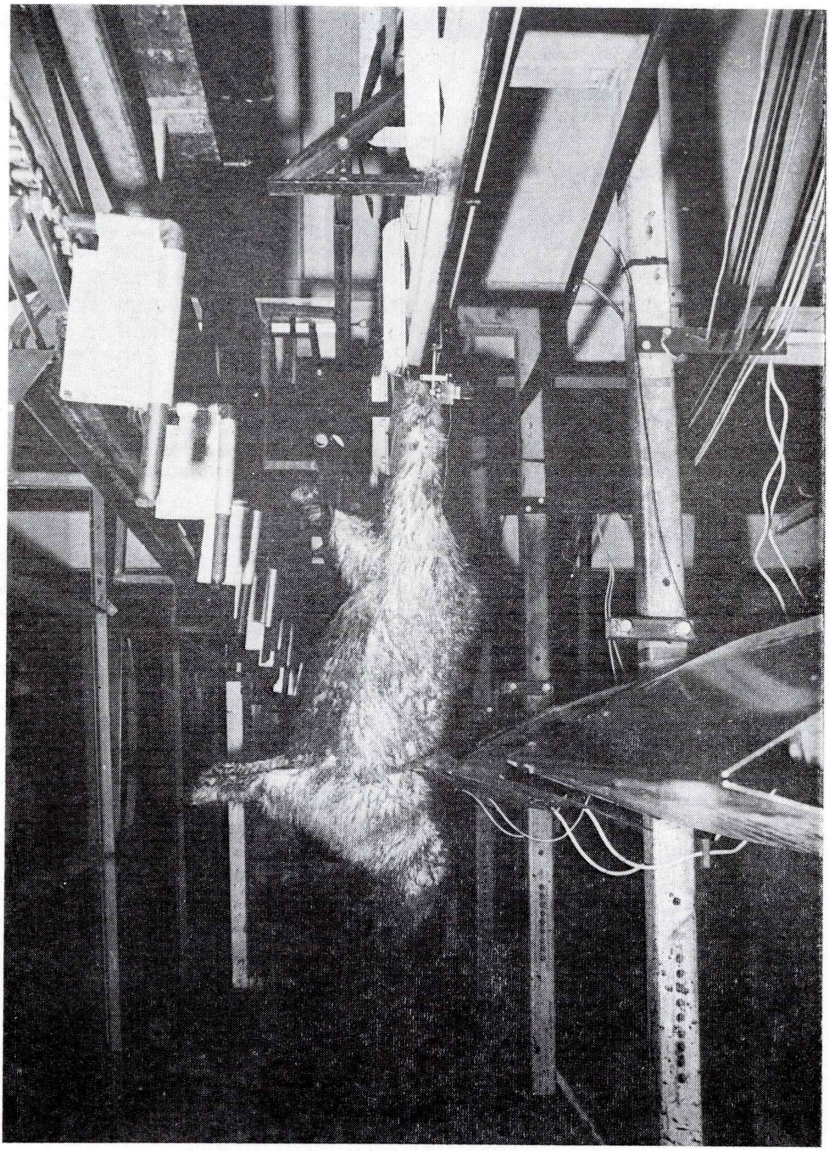
ACTIVITIES

The initial research programme concentrates on short-term, high-impact projects such as development of costing systems for logging and transport contractors; evaluation of equipment like power saws, tree shears, and safety helmets; and investigation of the cost and effectiveness of various log segregation and preparation practices.

Proposed longer term research includes identification of existing and expected operating conditions, both topographic and tree crop, during the forthcoming rotation (e.g., 30-year) period; completion of a topographic typing of existing forest and of further areas to be afforested and requiring logging during the coming 30-year period.

As well as undertaking its own research programme, the Association acts as an information bureau and collects, collates, and disseminates New Zealand and overseas research findings. A library will be established to assist in this activity.

The Association plans to become a fee-paying member of certain overseas research organisations to receive research reports which would otherwise be unavailable in New Zealand and to use whatever consultancy services these organisations provide.



Conditioning before freezing avoids toughening of meat. One way of conditioning is by applying high-voltage pulses immediately after slaughter. Here the current passes from the isolated meat rail through the carcass to the V-shaped electrode rubbing along the back of the carcass.

MEAT INDUSTRY RESEARCH INSTITUTE OF N.Z. (Inc.)

East Street, Claudelands, Hamilton
POSTAL ADDRESS: P.O. Box 617, Hamilton
TELEGRAMS: MIRINZ Hamilton TELEPHONE: 56 159 Hamilton
DIRECTOR: N. H. Law, MSc, MChemA, FRIC, FNZIC.
DEPUTY DIRECTOR: C. L. Davey, PhD *Cantab,* FNZIC.

Bioscience: C. L. Davey, PhD *Cantab,* FNZIC.
Biotechnology: P. M. Nottingham, PhD *Aberd.*
Engineering: D. P. Haughey, PhD *Edin,* CEng, AMIChemE.
Administration: J. van Harskamp, ACA.

STAFF at 31-3-76: 32 scientists, 45 science technicians, and 15 supporting staff.

The Institute (MIRINZ) is the principal research organisation serving the New Zealand meat industry. Its work is directed towards the fostering, promoting, and undertaking of research and development of all matters concerning meat, meat by-products, and their processing, and implementing results of this work in the New Zealand meat industry.

Current Projects

MUSCLE BIOLOGY: muscle structure and function; changes in muscle tissue during the onset of rigor mortis; the mechanism of rapid conditioning through electrical stimulation; accelerated conditioning and muscle ultrastructure; early determination of muscle ultimate pH; histology of overstretched muscle.

MEAT AND MEAT PRODUCTS: accelerated conditioning of lamb and beef; aging of lamb after accelerated conditioning; temperature coefficient of meat aging; waste meat recovery and refabrication; mutton-based small goods through meat flaking; new kidney products.

MEAT QUALITY: meat quality from pasture-fed and maize silage-fed beef cattle; comparison of chilled lamb with traditionally thawed lamb; palatability of meat from various beef breeds; quality of venison.

MEAT BY-PRODUCTS: preservation of blood; casings processing and preservation; rendering; new product development; recovery of meat proteins from bones.

MICROBIOLOGY: physiology of meat-spoilage organisms; biochemistry and microbiology of the spoilage process; growth and viability of Salmonellae in sheep and calves; Staphylococci in meat; packaging and the microflora of chilled meat; competitive growth of pathogenic and saprophytic organisms; microbiological quality control; hygiene and sanitation; electron microscopy as an aid to medical and veterinary diagnosis.

POLLUTION ABATEMENT: recovery of protein from wastes by chemical treatment and air flotation; in-plant abatement; water conservation and re-use; treatment of fellmongery wastes; solids waste treatment; production of single-cell protein; anaerobic treatment of meat wastes.

INDUSTRIAL SERVICES: properties of packaging films; cold-store construction materials; evaluation of wall cladding; analytical services; calibration of industrial instruments; electrical stunning; industrial noise abatement.

REFRIGERATION: refrigeration surveys; compressor testing; finned evaporator performance; handling and storage in cold stores and associated areas; meat loaders and the cold chain; mathematical models for heat transfer and process control during meat transportation; survey of energy use in a freezing works; thawing of frozen lamb and mutton carcasses; evaluation of automatic carcass freezers.

BY-PRODUCT PROCESSING: viscera cutting; pneumatic handling of offal; fluidized-bed drying of blood; blood collection and pre-treatment; blood concentration by ultrafiltration; agitation in dry rendering.

INSTRUMENTATION AND CONTROL: humidity measurement; radio telemetry; analogue control; computer control; electrical stunning; engineering aspects of electrical stimulation.

HISTORY AND ACTIVITIES

MIRINZ was established on a modest scale in 1955 and assumed the role of DSIR's meat section. The Institute was located at the Dominion Laboratory, Lower Hutt, before shifting to new laboratories in Hamilton in 1961. In 1973 laboratory space was more than doubled by the opening of the Neville Thomson Research & Development Building, and this gave impetus to further expansion of research and development activities.

The meat industry earns New Zealand its greatest amount of overseas exchange, mainly through the export of frozen meat. Thus research at MIRINZ has always emphasised the importance of refrigeration and its effect on product quality. Chilling carcasses of freshly slaughtered animals can cause toughening of the meat, but this is avoided if carcasses are conditioned before freezing. MIRINZ has developed an accelerated conditioning process in which carcasses are subjected to a series of high-voltage electric pulses immediately after slaughter. Conditioning is achieved within one hour compared with the normal 20 hour process, and carcasses can then be rapidly frozen without toughening of the meat.

N.Z. POTTERY AND CERAMICS RESEARCH ASSOCIATION (Inc.)

DSIR No. 2 Building, Gacefield Road, Lower Hutt
POSTAL ADDRESS: Private Bag, Lower Hutt
TELEGRAMS: PACRA Physical Lower Hutt TELEPHONE: 666 919 Wellington
DIRECTOR: H. J. Percival, PhD *Well.*
Ceramic Advisory Testing Service: Z. Demchenko, DipIngChem *Kharkov.*

STAFF at 31-3-76: 4 scientists, 3 technicians, and 2 supporting staff.

The Association (PACRA) engages in research work relevant to current interests of the New Zealand ceramics industry and provides a technical advice, information, and testing service for the industry. Research interests can be divided into two broad categories: investigations related to the improvement of the manufacturing processes and investigations aimed at improving the use of the final product.

Current Projects

SLIP RESEARCH: continuing studies of correlations between physical properties of slips and their corresponding plastic bodies, and between the physical properties of slips and their chemical nature. An important part of the work involves measurement of stress–strain properties of plastic clay. The measurements should aid the search for a more reliable assessment of the "workability" of plastic clay bodies.

MASONRY: an initial load-testing programme for brick veneer (reinforced and unreinforced) on timber studs has been started. Brick-mortar bond strength, timber backing stiffness, and stud spacing (and corresponding tie spacing) will be varied during the programme, which is aimed at demonstrating the seismic capacity of brick veneer under face loading.

PIPE STUDIES: examination of changes in the methods of drying and firing of pipes, the changes being aimed at improving dimensional tolerances and increasing the pipe length without increasing the pipe weight. For the latter thinner-walled pipes are necessary, and the required strength improvement in the pipe material has been considered. Practical methods for increasing strength are being investigated.

CERAMIC MATERIAL FRACTURE: a comprehensive survey of the literature on fracture mechanics and its application to ceramics has been completed. This review is a basis for PACRA's current and future work on crack growth behaviour of ceramics and the fracture toughness of ceramics. Apparatus for measurements of crack growth has been installed at PACRA. A technique for the preparation of test specimens is being developed and will be used to test the fracture properties of a range of ceramic materials.

HISTORY AND ACTIVITIES

Initial stimulus for the formation of a ceramics research association came from Dr E. Marsden, then Secretary of the DSIR. In 1944 he interested manufacturers of whitewares in the possibilities of co-operative industrial research, and in 1945 the Association was formed. An officer was seconded from DSIR as Director, and the first permanent Director was appointed in 1947. In 1950 heavy-clay-products manufacturers were admitted to the Association, with a resulting expansion of interests and activities.

PACRA realised in 1972 that a long period of successful research and the absence of innovation in the ceramics industry, as distinct from the development of existing products and production methods, had led to diminishing demands for further investigation of the ceramic-processing sequence. Thus, PACRA has shifted away from research on processing common to all members' products (forming, drying, and firing) towards more research on problems of individual ceramic products. This has also led to the introduction of a wider range of project advisory committees.

WOOL RESEARCH ORGANISATION OF N.Z. (Inc.)

Springs Road, Lincoln
POSTAL ADDRESS: Private Bag, Christchurch
TELEGRAMS: WRONZ Christchurch TELEPHONE: 8009 Halswell
DIRECTORS N. F. Roberts, MSc, FInstP, FTI.
SECRETARY: C. P. McEvedy, BCom, FCA.

Textile Technology: D. A. Ross, MAgrSc, PhD *Leeds.*
Wool Science: W. S. Simpson, MSc, PhD *Leeds,* FNZIC.
Scouring, Bleaching, and Slipe Wool: R. G. Stewart, MSc, CChem, MRIC.
Measurement and Marketing: A. R. Edmunds, MSc, PhD *Leeds,* FNZEI.
Engineering Services: A. Barker, CEng, MIMechE, MNZIE.
Scientific Services: L. F. Story, BSc, PhD *London,* CChem, MRIC.

The Organisation undertakes research on all matters relating to the utilisation of New Zealand wool, including chemical and physical properties, marketing, scouring, processing and end use performance.

Current Projects

TEXTILE TECHNOLOGY: self-twist spinning of crossbred wools; novel carpet constructions; manufacture of tufted blankets from crossbred wools; crossbred knitting yarns; variegated yarn products; processing and performance trials on a series of wool types and blends for tufted and woven products; carpet wear and performance ;artificial crimping and other methods of increasing yarn bulk.

WOOL SCIENCE: flameprofing; static in carpets; light degradation of wool; printing and dyeing; sheepskin technology including infant care rugs; polymer treatments of wool for carpets and ion-exchange felts; hygiene aspects of carpets in hospitals; structure and function of the growing follicle; lustre and medulation; utilisation of wastes.

SCOURING, BLEACHING, AND SLIPE WOOL: scouring plant improvements including liquor circulation and disposal, other effluent treatments, dryer control, heat recovery from scouring and dyeing effluents and from the exhaust air of dryers; measurement of wool whiteness, upgrading by bleaching.

MEASUREMENT AND MARKETING: examination of sale-by-sample systems; improvement of wool preparation; quality control of broker classing; reduction of fineness and length classes in relation to processing significance; wool-flow systems; slipe wool testing.

SCIENTIFIC SERVICES: testing and investigations for industry; synthetic woolpacks.

HISTORY AND ACTIVITIES

The Department has been associated with wool research since 1937 when the NZ Wool Manufacturers' Research Asociation was inaugurated at Dunedin as a branch of the DSIR to assist the wool milling industry. The Association became an independent body, the NZ Woollen Mills Research Association (Inc.), in 1945 and changed its name again, to the

NZ Wool Industries Research Institute (Inc.), in 1957 when its scope was extended to include the commission wool scouring industry.

The Wool Research Organisation was formed by the NZ Wool Board and the DSIR in 1961 to conduct research aimed at increasing knowledge of crossbred wool. Laboratories were built for it at Lincoln, near the College. Its terms of reference initially covered studies of wool structure, physics and chemistry, with particular regard to chemical modifications and new products, and also marketing.

The Wool Industries Research Institute was invited to occupy a section of the new laboratories at Lincoln from mid-1966, and in 1968 it wa sdecided to merge it completely with the Wool Research Organisation. The latter's constitution was therefore changed to permit industrial members and to enlarge its scope to include all aspects of wool processing and utilisation.

With a shift in emphasis from pure to applied research a pilot plant building was constructed and equipped in 1971 to enable new processes and products to be followed through from the laboratory bench to full scale production trials. DSIR has a nearly 50 percent share in financing all the research. Some highlights from the achievements of this sponsored research are:

1 The WRONZ Comprehensive Scouring System, which has been of tremendous benefit to the scouring industry in New Zealand. Associated effluent treatment has been examined in collaboration with Chemistry Division.

2 The Measurement and Marketing section's work towards simplifying and reducing the cost of marketing wool. Considerable financial savings have accrued from greater uniformity of classing wool, and intensive studies of sampling and measurement are leading to improved marketing methods.

3 Carpets are the largest end use for New Zealand wool. WRONZ has made a notable contribution to evaluating their performance.

4 The use of crossbred wools in knitwear has been examined with good prospects of their utilisation in this outlet.

5 It has been shown that (contrary to earlier opinion) crossbred wools can be spun on the self-twist system. This is now being done commercially.

DSIR SCIENTIFIC COLLECTIONS

The following scientific collections are held and maintained for research and reference by DSIR Divisions and grant-aided Research Associations.

Botanical

General Herbarium	Botany Division, Lincoln Ecology Division, Lower Hutt
Herbage Species Herbarium	Grasslands Division, Palmerston North
Fungal Herbarium	Plant Diseases Division, Mount Albert, Auckland
Seed Collections	Grasslands Division, Palmerston North Crop Research Division, Lincoln Tobacco Research Station, Riwaka

Zoological

INVERTEBRATES

Marine Invertebrates, Marine Benthos, Marine Plankton	Oceanographic Institute, Wellington
N.Z. Arthropod Fauna (non-marine, mainly insects)	Entomology Division, Mount Albert, Auckland
Freshwater Invertebrates	Ecology Division, Lower Hutt.
Nematodes (National Nematode Collection)	Entomology Division, Mount Albert, Auckland

VERTEBRATES

Rabbits, Hares, Rodents, Mustelids, and Wallabies	Ecology Division, Lower Hutt
Amphibians and Reptiles	Ecology Division, Lower Hutt

MICRO-ORGANISMS

Soil, Plant, and Industrial Pathogens	Plant Diseases Division, Mount Albert, Auckland
Dairy Pathogens	N.Z. Dairy Research Institute, Palmerston North
Meat Pathogens	Meat Industry Research Institute of N.Z. (Inc.)
Rumen Micro-organisms	Applied Biochemistry Division, Palmerston North
Rhizobium Strains	Applied Biochemistry Division, Palmerston North Plant Diseases Division, Mount Albert, Auckland

Geological and Soil

Petrological	Geological Survey, Lower Hutt
Paleontological (a) Macrofossil (b) Microfossil (c) Palynological	Geological Survey, Lower Hutt
Core Samples	Geological Survey, Lower Hutt
Soil Monoliths	Soil Bureau, Taita
Marine Surface Sediment Samples	Oceanographic Institute, Wellington
Marine Deep Water Sediment Cores	Oceanographic Institute, Wellington

RECENT PUBLICATIONS

Publications are arranged by Division, in alphabetical order of first Divisional author.

ANTARCTIC DIVISION

(Antarctic Division co-ordinates and implements all New Zealand Antarctic activities. Publications listed below are those of all organizations taking part; including other Divisions of DSIR, other Government departments, the Universities, and other research bodies.)

Allis, R. G.; Barrett, P. J.; Christoffel, D. A. 1975: A paleomagnetic stratigraphy for Oligocene and early Miocene marine glacial sediments at site 270, Ross Sea, Antarctica. *Initial reports of the Deep Sea Drilling Project vol. XXVIII:* 879–84.

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——— 1975: Sea water near the head of the Ross Ice Shelf. *Nature 256(5516):* 390–2.

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Ford, A. B.; Barrett, P. J. 1975: Basement rocks of the south-central Ross Sea, site 270, DSDP leg 28. *Ibid. vol. XXVIII:* 861–8.

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Bauchop, T.; Clarke, R. T. J. 1975: Gut microbiology and carbohydrate digestion in the larva of *Costelytra zealandica* (Coleoptera:Scarabaeidae). *N.Z. Journal of Zoology 2(2):* 237–43.

Bauchop, T.; Clarke, R. T. J.; Newhook, J. C. 1975: Scanning electron microscope study of bacteria associated with the rumen epithelium of sheep. *Applied Microbiology 30(4):* 668–75.

Biggs, D. R. 1975: Post-infectional compounds from the french bean *Phaseolus vulgaris;* isolation and identification of genistein and 2′,4′,5,7-tetrahydroxyisoflavone. *Australian Journal of Chemistry 28:* 1389–92.

Body, D. R. 1975: The occurrence of dihydrophytyl wax esters in bovine rumen liquor. *Biochimica et Biophysica Acta 380:* 45–51.

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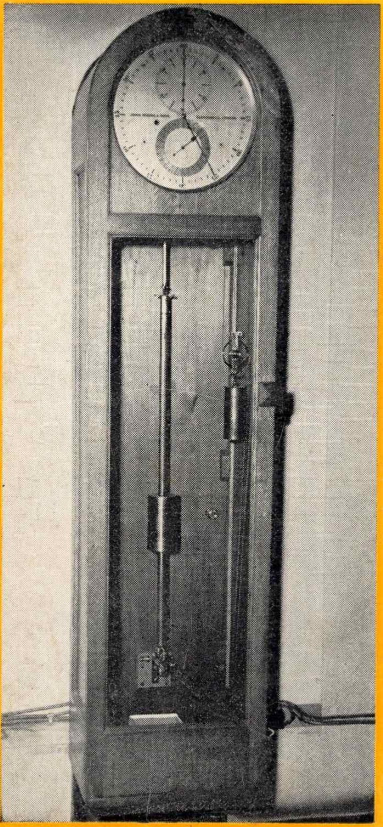
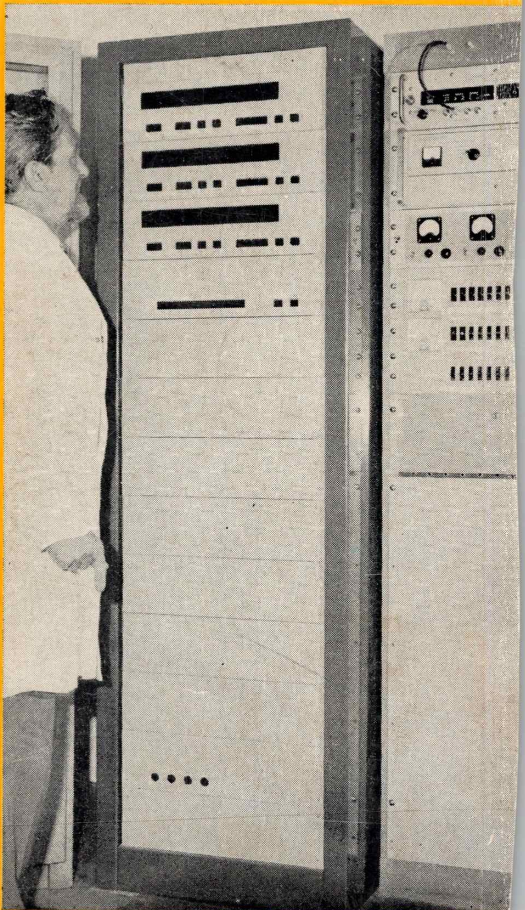


Times change . . . and so do the ways time
measured. When DSIR became responsible
the New Zealand time service 50 years ago
used two pendulum clocks purchased in 18
(one shown on left) to supply signals with
accuracy of no higher than $\frac{1}{4}$ second. Tod
at the DSIR Geophysics Division, Kelbu
New Zealand Standard Time is kept by a ti
signal transmitter *(below)* based on a qua
crystal clock which needs adjustment of o
one-thousandth of a second about every ni
months.

The 1864 clocks are still in working ord



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